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June 3, 2011

Mr. Eric Summa
Planning Division
Department of the Army Corps of Engineers
PO Box 4970
Jacksonville, Florida 32232

Dear Mr. Summa:

In response to a request from the Jacksonville District, and in partial fulfillment of our agreement to serve as a cooperating agency in the preparation of the Environmental Impact Statement (EIS) for the Port Everglades Expansion Project, we have prepared a report, *Characterization of Essential Fish Habitat in the Port Everglades Expansion Area.* The District may reference this information the EIS and Essential Fish Habitat (EFH) assessment to describe the habitats that would be affected by this project. While the report by itself does not constitute an EFH assessment, it contains several of the mandatory and other components described at 50 CFR 600.920(e)(2).

This report has been peer reviewed by several NOAA scientists and resource managers, including staff from the NOAA Restoration Center in St. Petersburg, Florida; NMFS Protected Resources Division in Ft. Lauderdale, Florida; and NBOAA Coral Reef Conservation Program in Silver Spring, Maryland; and the NOAA Center for Coastal Fisheries and Habitat Research in Beaufort, North Carolina. Records of all technical and editorial comments received are available should they be needed and the final report reflects all change requested. Most importantly, all reviewers concluded the information contained in the report accurately describes the habitats in the Port Everglades area.

Thank you for the opportunity to provide the report. Related correspondence should be directed to the attention of Ms. Jocelyn Karazsia at our West Palm Beach office, which is co-located with the US Environmental Protection Agency at USEPA, 400 North Congress Avenue, Suite 120, West Palm Beach, Florida, 33401. She may be reached by telephone at (561) 616-8880, extension 207, or by e-mail at Jocelyn.Karazsia@noaa.gov.

Sincerely,

Pace Wilber

/ for

Miles M. Croom
Assistant Regional Administrator
Habitat Conservation Division

Characterization of Essential Fish Habitats in the Port Everglades Expansion Area

This report was prepared by:
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NOAA National Marine Fisheries Service
Southeast Region, Habitat Conservation Division

June 3, 2011

Outline

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List of Acronyms

EFH	Essential Fish Habitat
HAPC	Habitat Area of Particular Concern
SAFMC	South Atlantic Fishery Management Council
FDEP	Florida Department of Environmental Protection
DCC	Dania Cut-off Canal
AIWW	Atlantic Intracoastal Waterway
IEC	Inner Entrance Channel
OEC	Outer Entrance Channel
SAC	South Access Channel
MTB	Main Turning Basin
FMP	Fishery Management Plan
EIS	Environmental Impact Statement

1. Essential Fish Habitat Overview

The 1996 amendments to the Magnuson-Stevens Fishery Conservation and Management Act (Magnuson-Stevens Act) require regional fishery management councils and federal agencies to promote protection, conservation, and enhancement of essential fish habitat (EFH). The EFH provisions of the Magnuson-Stevens Act support one of the Nation's overall marine resource management goals - maintaining sustainable fisheries. Achieving this goal requires maintenance of the quality and quantity of habitats necessary for fishery resources.

The Magnuson-Stevens Act defines EFH as "...those waters and substrate necessary to fish for spawning, breeding, feeding, or growth to maturity." Rules promulgated by the National Marine Fisheries Service (NMFS) in 2002 further clarify EFH with the following definitions: **waters -** aquatic areas and their associated physical, chemical, and biological properties that are used by fish and may include aquatic areas historically used by fish where appropriate; **substrate -** sediment, hardbottom, structures underlying the waters, and associated biological communities; **necessary -** the habitat required to support a sustainable fishery and the managed species' contribution to a healthy ecosystem; and **spawning, breeding, feeding, or growth to maturity -** stages representing a species' full life cycle. EFH may be a subset of all areas occupied by a species. Acknowledging that the amount of information available for EFH determinations will vary for the different life stages of each species, the rule directs the fishery management councils and NMFS to use the best available information, to take a risk averse approach to designations, and to be increasingly specific and narrow in the delineations of EFH as more refined information becomes available.

The rule also provides for fishery management councils and NMFS to consider more limited designations for each species. Habitat Areas of Particular Concern (HAPCs) are subsets of EFH that are rare, particularly susceptible to human-induced degradation, especially important ecologically, or located in an environmentally stressed area. In general, HAPCs include habitats important for the migration, spawning, and rearing of fish or shellfish. Actions with potential adverse impacts to HAPCs are more carefully scrutinized and subject to more stringent conservation recommendations.

The South Atlantic Fishery Management Council (SAFMC) designates mangrove; seagrass; hardbottom, coral, and coral reefs; intertidal flats; coastal inlets; and other bottom habitats within the Port Everglades project area as EFH (SAFMC 1998). In addition, the Mid-Atlantic Fishery Management Council designates coastal inlets as EFH for bluefish and the NMFS designates coastal inlets as EFH for a variety of sharks.

Within southeast Florida, including the Port Everglades project area, nearshore bottom, coral, coral reef, live/hardbottom, mangroves, seagrass, and coastal inlets are HAPCs (SAFMC 1998). Managed species that commonly inhabit the study area include pink shrimp (*Farfantepenaeus duorarum*); spiny lobster (*Panulirus argus*); and members of the 73-species snapper-grouper complex, including bluestriped grunt (*Haemulon sciurus*), French grunt (*H. flavolineatum*), mahogany snapper (*Lutjanus mahogoni*), yellowtail snapper (*Ocyurus chysurus*), and red grouper (*Epinephelus morio*). These species use inshore habitats as juveniles and sub-adults, and offshore hardbottom and reef communities offshore as adults. Other species of the snapper-grouper complex commonly seen offshore in the study area include gray triggerfish (*Balistes capriscus*) and hogfish (*Lachnolaimus maximus*). Coastal migratory pelagic species also commonly utilize the offshore area adjacent to the study area, including cero (*Scomberomorus regalis*) and Spanish mackerel (*S. maculatus*). As many as 60 coral species can occur off the coast of Florida (SAFMC 2009) and these resources fall under the protection of the SAFMC coral, coral reefs, and live/hardbottom Fishery Management Plan (FMP).

Table 1: Federally managed species, categorized by FMP, and species habitat affinity in the Port Everglades project area

Fishery Management Plan (FMP)	Federally Managed Species Known to Occur in Pt Everglades		EFH within the Pt Everglades Expansion Areas	HAPC within the Pt Everglades Expansion Areas
Snapper-grouper FMP	**Grunts (all 11 species)**	**Snappers (8 of 14 species)**	**Outer Entrance Channel**	
	Black margate (*Anistotremus surinamensis*)[2,3]	Juvenile snappers (*Lutjanus* spp.)[1]	live/hardbottom and coral reefs	medium to high profile hardbottoms
	Porkfish (*Anisotremus virginicus*)[2]	Mutton snapper (*Lutjanus analis*)[2]	attached macroalgae	nearshore hardbottom areas
	Grunts (*Haemulon* spp.)[1]	Schoolmaster (*Lutjanus apodus*)[3]	unconsolidated bottom (soft sediments)	all hermatypic coral habitats and reefs
	Margate (*Haemulon album*)[3]	Gray snapper (*Lutjanus griseus*)[2]		
	Tomtate (*Haemulon aurolineatum*)[3]	Dog snapper (*Lutjanus jocu*)[3]	**Interior Areas of Port Everglades**	
	Smallmouth grunt (*Haemulon chrysargyreum*)[3]	Mahogany snapper (*Lutjanus mahogoni*)[3]	submerged aquatic vegetation (SAV; seagrass and macroalgae)	mangrove habitat
	French grunt (*Haemulon flavolineatum*)	Lane snapper (*Lutjanus synagris*)[3]	tidal creeks	seagrass habitat
	White grunt (*Haemulon plumierii*)[1]	Yellowtail snapper (*Ocyurus chrysurus*)	estuarine scrub/shrub (mangrove fringe)	coastal inlet
	Bluestriped grunt (*Haemulon sciurus*)[1]	**Groupers and Sea basses (12 of 21 species)**	unconsolidated bottom (soft sediments)	
	Sailor's choice *(Haemulon parra)*[3]	Rock hind (*Epinephelus adscensionis*)[3]		
	Cottonwick (*Haemulon melanurum*)[2]	Red grouper (*Epinephelus morio*)		
	Spanish grunt (*Haemulon macrostomum*)[2]	Red hind (*Epinephelus guttatus*)[3]		
	Porgies (5 of 9 species)	Coney (*Cephalopholis fulva*)[2]		
	Porgy (*Calamus spp.*)[2]	Graysby *(Cephalopholis cruentata)*[2]		
	Jolthead porgy (*Calamus bajonado*)[3]	Bank sea bass (*Centropristis ocyurus*)[3]		
	Knobbed porgy (*Calamus nodosus*)[3]	Black grouper (*Mycteroperca bonaci*)[3]		
Sources of information:	Littlehead porgy (*Calamus proridens*)[3]	Gag (*Mycteroperca microlepis*)[3]		
[1] DCA 2001	Saucereye porgy (*Calamus calamus*)[3]	Scamp (*Mycteroperca phenax*)[3]		
[2] DCA 2006	Sheepshead porgy (*Calamus penna*)[3]	Yellowfin grouper (*Mycteroperca venenosa*)[3]		
no subscript indicates reported in both both DCA 2001 & 2006	**Jacks (5 of 8 species)**	*Y*ellowmouth grouper (*Mycteroperca interstitialis*)[3]		
	Blue runner (*Caranx crysos*)[2]	**Tilefishes (1 of 3 species)**		
	Bar jack (*Caranx ruber*)	Sand tilefish (*Malacanthus plumieri*)[2]		
[3] Not reported in DCA 2001 or DCA 2006, but reported in Ferro et al. 2005	Horse-eye Jack (*Caranx latus*)[3]	**Triggerfishes (3 of 3 species)**		
	Yellow jack (*Caranx bartholomaei*)[3]	Gray triggerfish (*Balistes capriscus*)		
	Almaco jack (*Seriola rivoliana*)[3]	Queen triggerfish (*Balistes vetula*)[2]		
	Wrasses (2 of 2 species)	Ocean triggerfish (*Canthidermis sufflamen*)[3]		
	Puddingwife (*Halichoeres radiatus*)[2]	**Spadefishes (1 of 1 species)**		
	Hogfish (*Lachnolaimus maximus*)[1]	Spadefish (*Chaetodipterus faber*)[2]		
Shrimp FMP (Penaeid)	None observed but since commercial fisheries exists to the north and south of the inlet, the persence of pink shrimp (*Farfantepenaeus duorarum*) is likely. DCA 2001 states that pink shrimp commonly inhabit the study area.		**Outer Entrance Channel**	
			offshore marine habitats used for spawning and growth to maturity [sand bottom]	
			Interior Areas of Port Everglades	
			subtidal and intertidal non-vegetated flats	coastal inlet
			all interconnected water bodies [to connect areas with appropriate sediment types]	
			mangroves	
			marine and estuarine sav (e.g., seagrass)	
Spiny lobster	None observed, but highly likely. DCA 2001 states that *Panularis argus* commonly inhabit the study area.		**Outer Entrance Channel**	
			coral and live/hardbottom habitat	coral/hardbottom habitat from Jupiter Inlet through the Dry Tortugas
			shalllow subtidal bottom	
			sponges	
			unconsolidated bottom (soft sediments)	
			Interior Areas of Port Everglades	
			seagrass	
			algal communities (*Laurencia* spp.)	
			mangrove habitats (prop roots)	
Coastal Migratory Pelagics	Spanish mackerel (*Scomberomorus maculatus*)[1]		**Outer Entrance Channel**	
	Cero (*Scomberomous regalis*)[2]		high profile rocky bottom	nearshore hardbottom south of Cape Canaveral
	Cobia (*Rachycentron canadum*)[3]		barrier island ocean-side waters from the surf break to the shelf break	*Phragmatopoma* worm reefs
			Interior Areas of Port Everglades	
			seagrass	

Table 1 cont'd:

Fishery Management Plan (FMP)	Federally Managed Species Known to Occur in Pt Everglades		EFH within the Pt Everglades Expansion Areas	HAPC within the Pt Everglades Expansion Areas
	Acropora cervicornis [1]	*Mycetophyllia ferox* [2]	**Outer Entrance Channel**	
Coral, Coral Reefs, Live/Hardbottom Habitat	*Agaricia agaricites*[2]	*Mycetophyllia lamarckiana* [2]	rough, hard, exposed, stable substrate from Palm Beach County south through the Florida Reef Tract in 30 m depth	nearshore (0-4 m, 0-12 ft) hardbottom
Sources of information:	*Agaricia lamarcki* [2]	*Phyllangia americana* [2]	for ahermatypic corals hard substrate in subtidal to outer shelf depths	offshore (5-30 m, 15-90 ft) hardbottom from Palm Beach to Fowey Rocks
[1] DCA 2001	*Colpophyllia natans* [2]	*Porites astreoides*[2]	EFH for Antipatharia includes rough, hard, exposed, stable substrate offshore in high (30-35‰) salinity waters in depths exceeding 18 m (54 ft)	*Phragmatopoma* worm reefs
[2]DCA 2006	*Dichocoenia stokesii*[2]	*Porites porites* [2]	EFH for octocorals (excludes the Order Pennatulacea) includes rough, hard, stable substrate in subtidal to outer shelf depths	
[3]FDEP 2008	*Diploria clivosa* [3]	*Scolymia spp.* [2]		
	Diploria labyrinthiformis[2]	*Briareum*[2]		
	Diploria strigosa[2]	*Ellisella*[2]		
	Eusmilia fastigiata [2]	*Erythropodium*[2]		
	Leptoseris cucullata[2]	*Eunicea* [2]		
	Madracis decactis[2]	*Iciligorgia* [2]		
	Madracis pharensis [3]	*Muricea*[2]		
	Manicina areolata [2]	*Muriceopsis* [2]		
	Meandrina meandrites [2]	*Plexaura*[2]		
	Montastraea annularis[2]	*Plexaurella*[2]		
	Montastraea cavernosa[2]	*Pseudoplexaura*[2]		
	Mussa angulosa [2]	*Pseudopterogorgia*[2]		
	Mycetophyllia aliciae [2]	*Pterogorgia*[2]		
Highly Migratory Species FMP	Finetooth shark (*Carcharhinus isodon*)[1]		**Outer Entrance Channel**	
	Lemon shark (*Negaprion brevirostris*)[1,2]		lemon and nurse sharks have habitat affinity for coral reefs	
[1] Wiley & Simpfendorfer 2007	Tiger shark (*Galeocerdo cuvier*)[1]		**Interior Areas of Port Everglades**	
[2] Snelson & Williams 1981	Atlantic sharpnose shark (*Rhizoprionodon terraenovae*)[1]		tiger and Atlantic sharpnose sharks have affinity for seagrass habitats	
[3] Ferro et al. 2005	Nurse shark (*Ginglymostoma cirratum*)[1,2,3]		nurse and lemon sharks have affinity for mangrove habitat	
	Bonnethead (*Sphyrna tiburo*)[1,2]		tiger, finetooth, and Atlantic sharpnose sharks have affinity for soft bottom habitats	

While not part of the currently proposed action, the Port is considering additional work that may impact two of the seagrass assessment areas (see Figure 1, areas 6 and 7) and six of the seven mangrove assessment areas (see Figure 3). The Council on Environmental Quality (1997) directs that descriptions of baseline conditions in the Affected Environment Section of the Environmental Impact Statement (EIS) provide the necessary context for evaluating cumulative effects in other sections of the EIS. Based on this guidance, mangrove and seagrass assessment areas that are not part of the currently proposed action are included in this appendix of the EIS. This approach recognizes the mobility of fishery resources within nearby habitat types and among different habitat types.

2. Seagrass

2.1 Review of literature, related information, and views of recognized experts on the habitat or species that may be affected

<u>2.1.1 Community composition of seagrass in the Port Everglades area</u>
Since 1999, the seagrass community in the Port Everglades area has included *Halophila decipiens, H. johnsonii*, and *Halodule wrightii*. The seagrass habitats are spatially and temporally dynamic, but persistently present within each of the seven assessment areas (Figure 1; Table 3). Regardless of species composition or developmental stage, seagrass patches and entire beds can move, the rate of which may vary on scales of weeks to decades (SAFMC 2009). The expansion and contraction of seagrass beds, also referred to as "pulsating patches" may be a long-term survival strategy of *H. johnsonii* (Virnstein et al. 2009) and other seagrass species. For impact assessment purposes, it is important to consider the broader seagrass habitat and not just the currently vegetated portions. Seagrass habitats include not only continuous vegetated beds, but also patchy environments with unvegetated areas between the patches as part of the habitat (SAFMC 2009). Available data show that patchy habitats provide ecological functions similar to continuous meadows (Murphey and Fonseca 1995). The absence of seagrass in a particular location during an isolated survey event does not necessarily mean that the location is not viable seagrass habitat and could be considered as potential habitat if the environmental conditions are suitable. It could indicate present conditions are unfavorable for growth at that moment in time, and the duration of this condition could vary from months to years (SAFMC 2009).

Virnstein et al. (2006) observed seagrass coverage expansion within a year and concluded that seagrass responds rapidly to changing environmental conditions. Because seagrass coverage and density in the Port Everglades area are dynamic, this may also indicate high resilience to changing environmental conditions. However, the consequences of human development and other anthropogenic pressures in a coastal basin and the loss of natural hydrologic buffers can compromise an estuary's resilience to rapidly recover from natural pressures, e.g., hurricanes and seasonal salinity fluctuations (Steward et al. 2006).

<u>*Halophila decipiens*</u>
Halophila decipiens is the only seagrass species identified in all seven assessment areas during survey events. *Halophila decipiens* is also the only seagrass species that has been observed in assessment areas 1 (Outer Entrance Channel, OEC) and 3 (Inner Entrance Channel, IEC) (Figure 1). This species is highly fecund and cosmopolitan, occupying niches that larger-sized perennial species cannot utilize (Hammerstrom and Kenworthy 2003). The short life history of *H. decipiens* and the apparent existence of a buried, but moveable seed bank indicates that spatial organization of this community is dictated first by large-scale dispersal of plant propagules (to hundreds of meters) and then, within a growing season, through physical perturbation, bioturbation, and clonal organization of the seagrass operating over very small distances (Fonseca et al. 2007). This species can contribute to a more clumped distribution early in the growing season with subsequent vegetative extension. Fonseca et al. (2008) point out that large-scale disturbance events, such as hurricanes, act to redistribute *H. decipiens* propagules, whereupon clonal

organization of the plants in their spring to fall existence likely dictates the pattern of seafloor occupation. Furthermore, bioturbation plays an important role in either burying seeds or bringing seeds to the sediment surface where they can germinate. They further note that this species appears to have the facility for resiliency of natural disturbances (e.g., hurricanes) of its community that appear to be able to move the seed bank hundreds, if not thousands, of meters, leading to tremendous seasonal changes in the spatial distribution of the plants. The small seed size and the burial of unvegetated substrate by sediments, coupled with movement along with sediment is a plausible mechanism to explain the inter-annual patterns of seagrass distribution (*sensu* Josselyn et al. 1986). Thus, the definition of "seagrass habitat" for *Halophila* can be highly misleading if presently vacant spaces among patches are not properly considered as requisite space for persistence of the community (*sensu* Fonseca et al. 1998).

Although *H. decipiens* is small and present only through a few months of the year, the species provides significant sediment stabilization (Fonseca 1989). Despite a small size and a relatively low rate of production, *H. decipiens* makes an important contribution to primary production in an ecosystem (Iverson and Bittaker 1986). It is important to note that *H. decipiens* communities are a mosaic of seasonally ephemeral seagrass patches that provide the valuable ecological functions recognized for the larger seagrasses (Hammerstrom et al. 2006), therefore the patchy abundance of *Halophila* is a function of the genus dynamics and should be recognized as the ambient condition (Jud Kenworthy, PhD., personal communication, NOAA National Centers for Coastal and Ocean Science, 2010). Rapid growth, high turnover rates, and labile tissues make *Halophila* spp. a good source of nutrition for several marine herbivores and detritivores (Kenworthy et al. 1989).

<u>*Halodule wrightii*</u>

Halodule wrightii occurred in four of the seven seagrass assessment areas including areas 2, 5, 6, and 7. It was not observed in any of the seagrass assessment areas in 2006 (DCA 2006), however it was observed in the middle and southern reaches of the Port Everglades area during 2008 and 2009, primarily in assessment areas 5, 6, and 7. *Halodule wrightii* is a highly productive seagrass under a variety of light, nutrient, and salinity conditions and because of this it is known to have ubiquitous distribution and an opportunistic strategy as a colonizing species (Dunton 1996). This species can persist under diminishing environmental conditions by reclamation of nutrients and stored reserves from senescing shoots and rhizomes (Onuf 1996). Rhizome growth and branch rate for *H. wrightii* is high compared to climax seagrass species (e.g., *Thalassia testudinum*) which allows the species to rapidly occupy the space it colonizes, however it has a high shoot mortality and low life expectancy which implies it may not occupy the space over a long period of time (Gallegos et al. 1994).

Heidelbaugh (1999) conducted a study within a 372 m^2 (0.09 acres) study area that examined benthic fauna associated with seagrass and unvegetated bottoms and collected 117 species and 690 macrofaunal organisms from *H. wrightii* beds. The most abundant infaunal organisms belonged to the phylum Nematoda while the most abundant epifaunal species were amphipods and tanaids. The majority of macrofaunal organisms consisted of decapod crustaceans (*Callinectes sapidus*), fishes (*Eucinostomus* sp.), and some gastropods (especially *Bursatella leachii*). An additional study compared nekton densities among *H. engelmannii*, *H. wrightii*, and nonvegetated habitats and, similar to the results of the Heidelbaugh (1999) study, found higher densities in the seagrass habitats (King and Sheridan 2006). These studies and others (Sheridan and Livingston 1983; Stoner 1983; Lewis 1984) conclude that on a per plant biomass basis, *Halodule* provides as much fish and infaunal habitat value as other species with higher above-ground biomass, such as *Thalassia testuninum*.

Halophila johnsonii

Under the Endangered Species Act, the Jacksonville District will separately consult with NMFS on potential effects to threatened *H. johnsonii* from the proposed action, however it is important to note that Johnson's seagrass, like other seagrass species, is also designated as EFH.

Halophila johnsonii was documented by at least one survey in all assessment areas except the OEC and IEC. In 2006, *H. johnsonii* was not observed in two assessment areas where it was previously observed (areas 5 and 6), however it returned to these areas in 2009 (Figure 2). The expansion and contraction of *H. johnsonii*, also referred to as "pulsating patches", may be a long-term survival strategy (Virnstein et al. 2009). The persistent presence of high density, elevated patches of *H. johnsonii* on flood tidal deltas near inlets suggests that it is capable of sediment stabilization (NMFS 2007). Given the similarities between the morphology of other *Halophila* spp. and *H. johnsonii,* it is reasonable to assume that *H. johnsonii* has the same capabilities as these other species to provide important ecological functions and services to the coastal ecosystem of southeastern Florida (NMFS 2007).

In the Heidelbaugh study (1999), *H. johnsonii* beds yielded a total of 126 species (69 epifauna and 57 infauna). Three hundred and twenty macrofaunal organisms were collected from *H. johnsonii* beds. NMFS has concluded that the conservation of *H. johnsonii* will not only maintain the diversity of the seagrass communities, but also the important biodiversity and biophysical characteristics of the entire ecosystem (NMFS 2007).

2.1.2 Ecological functions of seagrass and seagrass as EFH

The SAFMC designated seagrass as EFH for species managed under the snapper-grouper, spiny lobster, and coastal migratory pelagics FMPs. See Table 1 for a list of species associated with seagrass habitats and documented in the project area. Gray snapper (*Lutjanus griseus*) was observed in both reef fish surveys (DCA 2001; DCA 2006). Other studies from Florida have reported that young gray snapper are frequently captured in shrimp trawls in seagrass beds at night (Serafy et al. 2007). Other species managed under the snapper-grouper FMP that show an affinity for seagrass habitat include juvenile dog snapper (*L. jocu*), goliath grouper (*Epinephelus itajara*), bluestriped grunt, spiny lobster, and pink shrimp. Additionally, species managed under the highly migratory species FMP, such as tiger (*Galeocerdo cuvier*) and Atlantic sharpnose (*Rhizoprionodon terraenovae*) sharks have an affinity for seagrass habitats.

Many ecological functions are associated with seagrass, including nutrient recycling, detrital production and export, sediment stabilization, and provision of food and habitat for many life stages of numerous marine species. The most well-known function of seagrass is the role as habitat for numerous fishes and invertebrates. Some species spend their entire lives within seagrass beds and others utilize them only during certain stages of their life cycles (usually the postlarval and juvenile stages). Seagrass beds are one of the primary nursery habitats for coastal marine fauna because of their abundance of prey items as well as the protection they provide from predators. Like many of the larger species, *Halophila* species provide organic matter, habitat structure, and food for benthic feeding organisms (Valentine and Heck 1999). In addition, *Halophila*-based ecosystems provide important food for herbivorous reptiles (Ross 1985).

Seagrass habitats perform numerous important functions in coastal ecosystems that aid in successful spawning, feeding, and growth of several seasonal and resident fishery species, thus serving as EFH. SAFMC (2009) provides a review of several studies which have concluded that, although juvenile fish and shellfish can use other types of habitat, many estuarine species rely on seagrass for either part of their life history or some aspect of their nutrition, and that the loss or reduction of this habitat will produce concomitant declines in juvenile fish settlement. Seagrass habitat type is essential to many species of commercial, recreational and ecologically important shellfish and finfish (SAFMC 2009). *Halophila*-

based ecosystems, as occur in the Port Everglades project area, are particularity important habitats for penaeid shrimp (Ross 1985). Scientific evidence also indicates other species have a strong reliance on seagrass habitats, including blue crabs and spiny lobster (SAFMC 2009).

One of the more important functions of seagrass as EFH is the nursery role. Seagrass habitats serve as nurseries for juvenile fish and their food sources. Seagrass habitats also affect ecological processes which enable fish to grow and mature to different ontogenetic stages, eventually reaching adult forms and emigrating to other habitats (Orth et al. 1984; Koenig and Coleman 1998). Several studies indicate that juvenile fishes are the most abundant age group in seagrass beds, especially in more temperate waters (SAFMC 2009). In particular, juvenile yellowtail snapper and French grunt are highly associated with seagrass beds (Cocheret de la Moriniere et al. 2002). Seagrass functions as a nursery is critical for many estuarine dependent fishery species in the South Atlantic region such as gag (*Mycteroperca microlepis*), flounders (family Pleuronectidae), red drum (*Sciaenops ocellatus*), weakfish (*Cynoscion regalis*), and striped mullet (*Mugil cephalus*) (Thayer et al. 1984).

The same ecological characteristics of seagrass beds that make the habitat favorable for juveniles similarly benefit larval fish and invertebrates. There have been a few studies dealing with larval fish settlement and use of seagrass habitats. Parish (1989) documented that seagrass provides habitat for settling postlarvae and developing juvenile reef fishes. Seagrass beds are important for the brooding of eggs (for example, Altantic silverstripe halfbeak, *Hyporhamphus unifasciatus*) and for fishes with demersal eggs (e.g., rough silverside, *Membras martinica*). Larvae of spring-summer spawners such as anchovies (*Anchoa* spp.), gobies, (*Gobiosoma* spp.), northern pipefish (*Syngnathus fuscus*), weakfish, southern kingfish (*Menticirrhus americanus*), red drum, silver perch (*Bairdiella chrysoura*), rough silverside, feather blenny (*Hypsoblennius hentz*), and halfbeaks are present and use seagrass beds (SAFMC 2009).

A large proportion of the seasonal residents of seagrass habitats in the South Atlantic region spawn offshore on continental shelves and reefs, enter the estuaries in late winter and early spring and take up residency until fall or until they reach a certain ontogenetic stage when they move to other habitats or offshore to renew this cycle. The proximity of seagrass to the Port Everglades Inlet may increase the value of the seagrass habitats located near the inlet, in particular for oceanic and estuarine spawners. Gilmore (1995) concluded that estuarine-ocean inlet seagrass meadow fish faunas are ontogenetically coupled with rich nearby ocean reef fish communities and support the richest estuarine ichthyofauna (214 species from seagrasses, 282 from ocean inlets). In addition, ocean inlet seagrass meadows are preferred habitat for mutton snapper juveniles (*Lutjanus analis*) (Gilmore 1995). Red drum, speckled trout (*Cynoscion nebulosus*), and weakfish spawn near inlet systems in late summer and fall and use seagrass as nursery areas (Street et al. 2005). In addition to seasonal and migratory species, there are resident fish species and other fauna that continuously utilize seagrass beds (Sogard et al. 1987).

In addition, seagrass habitats transfer unique biological, physical and chemical characteristics to water bodies which both directly and indirectly contribute to the necessary attributes of EFH (Zieman 1982; Thayer et al. 1984). Seagrass habitats play an important role as EFH by influencing the environment they grow in as well as adjacent environments. Essentially, seagrass habitat affects water flow, velocity, and turbulence, thereby creating an environment favorable to settlement of fish and fish food. Organic and inorganic particles settle into the seagrass beds providing nutrients and food, enriching the environment and enhancing secondary production. In turn, the substrate is stabilized, nutrients are temporarily conserved within the meadows and water quality is improved by the presence of seagrass. These ecological services enhance the environmental conditions favoring high rates of primary and secondary production in support of healthy and abundant fish communities (SAFMC 2009).

2.2 Review of available seagrass surveys

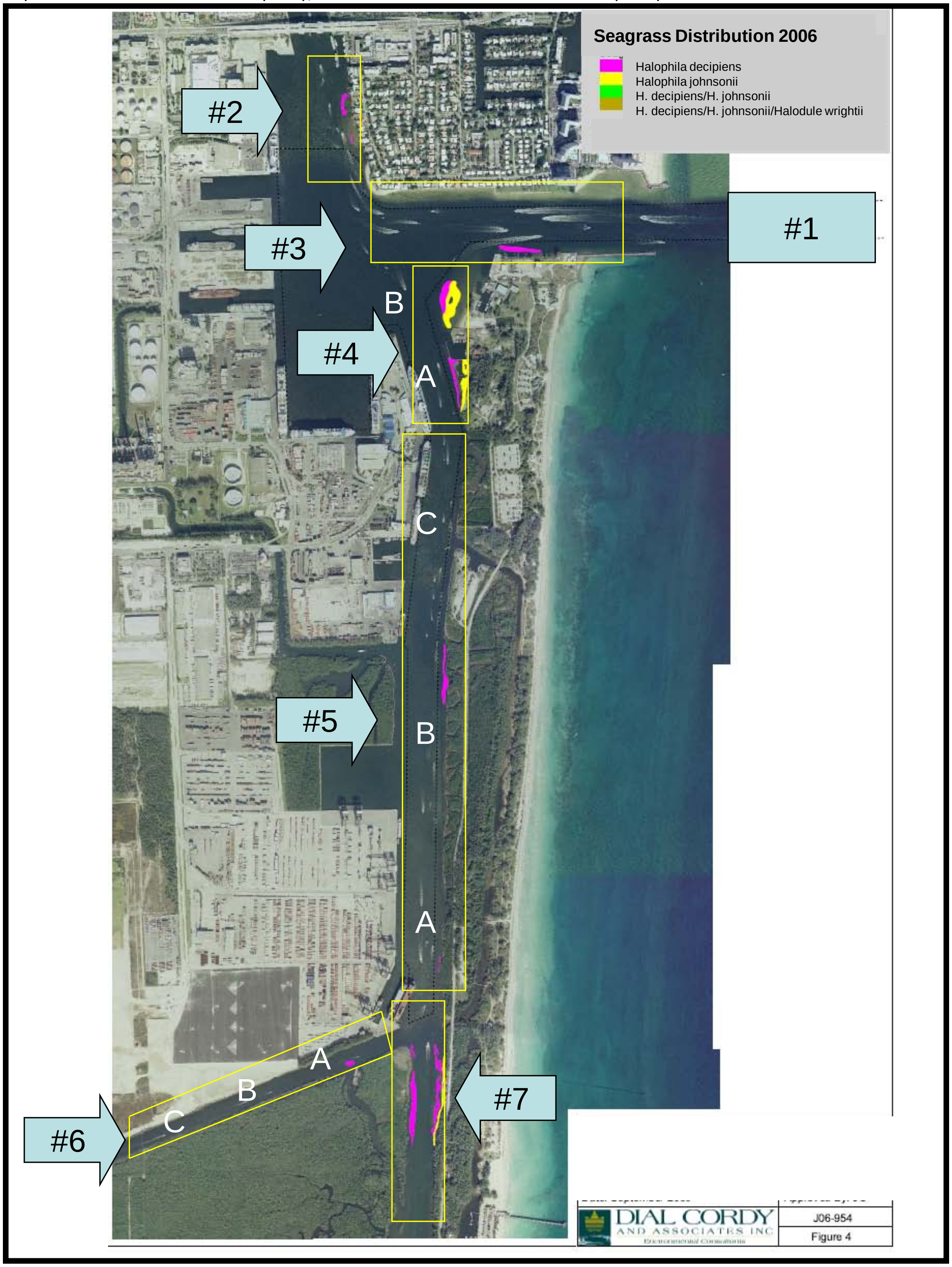
NMFS characterized seven seagrass assessment areas that were defined based on similarities in water depth, water quality and clarity, and landscape position (Figure 1). A summary of each assessment area is provided below and is based on six seagrass mapping, surveying, or verification efforts conducted in Port Everglades between 1999 and 2009 (Table 2).

Table 2: Seagrass surveys performed in the Port Everglades Area between 2001 to 2009

Study reference	**Date of Study**	**Spatial Scope of Survey**
DCA 2001	1999 to 2001	Expansion area (except Outer Entrance Channel) and surrounding areas
DCA 2001	2001	Outer Entrance Channel
DCA 2006	2006	Areas where seagrass was observed in DCA 2001
FDEP 2008	2008	Project area, except Outer Entrance Channel and portions of the South Access Channel
Miller Legg 2009	2008 to 2009	Dania Cut-off Canal
DCA 2009	2009	Expansion area, except Outer Entrance Channel

DCA (2001), based on a survey performed from 1999 to 2001, documented 8.71 acres of seagrass within the study area. This survey report includes results from an integrated video assessment conducted in May 2001 that identified *Halophila decipiens* in the OEC. DCA (2006), based on a survey performed in 2006, documented 8.44 acres of seagrass within the study area. The Florida Department of Environmental Protection (FDEP, 2008) provided seagrass polygon and point data from an interagency verification survey in the Port Everglades Area during June 2008. This verification survey was completed by representatives of FDEP, NMFS, Broward County, Jacksonville District, Florida Fish and Wildlife Conservation Commission (FWC), and Fish and Wildlife Service. The purpose of the verification survey was to define specific seagrass assessment areas for the purposes of completing a Uniform Mitigation Assessment Method, to verify the results of previous surveys, and to determine if seagrass had expanded into new areas. In August 2008 and August 2009, additional surveys were completed along the Dania Cut-Off Canal (DCC) portion of the project area associated with a separate project at West Lake Park (Miller Legg 2009). In 2009, 11.98 acres of seagrass were documented in the project area (DCA 2009). In 2009, NMFS and FWC completed an additional verification survey in the DCC. Table 3 provides the acreage of seagrass within each assessment area for each survey in addition to the cumulative acreage for the assessment area over multiple survey years.

Figure 1 : Seagrass assessment areas (modified from figure 4 in DCA 2006). Note area 1 is the Outer Entrance Channel (OEC); area 3 is the Inner Entrance Channel (IEC); area 5 is within the Atlantic Intracoastal Waterway (AIWW) or South Access Channel (SAC); area 6 is the Dania Cut-off Canal (DCC)



Seagrass Assessment Area 1:
This area is located within the Outer Entrance Channel and supports 1.04 acres of *H. decipiens* (DCA 2001). This area has not been re-surveyed since 2001. Therefore, the 2001 acreage is used as the cumulative acreage of this area.

Seagrass Assessment Area 2:
This is the northernmost seagrass area within the proposed Port expansion area and is north of the IEC and main turning basin (MTB) and along the eastern side of the Atlantic Intracoastal Waterway (AIWW). In 1999, this area contained 1.54 acres of mixed *H. decipiens*, *H. johnsonii*, and *Halodule wrightii* (DCA 2001). In 2006, the area contained 0.63 acres of *H. decipiens* (DCA 2006). The 2008 interagency verification survey of this area did not reveal any notable changes in seagrass distribution, however a mixed *H. decipiens* and *H. johnsonii* bed along the east slope of the AIWW was observed. In 2009, the area contained 0.13 acres of *H. johnsonii*, a decrease in acreage and a notable shift from a mixed seagrass community to a monospecific bed. The cumulative coverage is 2.07 acres (Table 3).

Table 3: Cumulative seagrass area by assessment site.

Seagrass Assessment Area	2001 Acres	2006 Acres	2009 Acres	Cumulative Acres
1	1.04	Not surveyed	Not surveyed	1.04
2	1.54	0.63	0.13	2.07
3	0.68	0.58	0.09	0.75
4	1.26	3.89	3.87	5.51
5	0.84	0.55	0.05	1.15
6	0.24	0.12	0.74	1.01
7	4.11	2.67	7.11	7.92
Total	**9.70**	**8.44**	**11.98**	**19.45**

Seagrass Assessment Area 3:
This area is located within the IEC and the MTB. In 2001, *H. decipiens* was documented along the northern side of the IEC (DCA 2001) and in 2001 and 2006 *H. decipiens* was documented along the southern side of the IEC (DCA 2001; DCA 2006). In 2008, additional *H. decipiens* was observed along the entire northern side of the IEC and along the south side of the IEC. Although the seagrass bed along the southern side of the IEC extended to the east, additional points were not collected (FDEP 2008). In 2009, *H. decipiens* was documented along the northern and southern sides of the IEC (DCA 2009). In 2001, the seagrass acreage in this area was 0.68 acres and in 2006 the seagrass acreage was 0.58 acres. In 2009 the seagrass acreage in this area was 0.09 acres. The cumulative acreage is 0.75 acres (Table 3).

Seagrass Assessment Area 4:
This area is located south of the IEC. In 2001 this area contained 1.26 acres of monospecific *H. johnsonii* (DCA 2001) and in 2006 this area contained 3.89 acres of *H. johnsonii* and *H. decipiens* (DCA 2006). This area was not verified in 2008. In 2009, the area contained 3.87 acres of mixed *H. decipiens* and *H. johnsonii* (DCA 2009). The cumulative acreage is 5.51 acres (Table 3).

Seagrass Assessment Area 5:
This area is located along the southern access channel (SAC). In 2001, the area contained 0.84 acres of *H. johnsonii*, *H. decipiens*, and *Halodule wrightii* (DCA 2001). In 2006, this area contained 0.55 acres of *H. decipiens* (DCA 2006). In 2009, the area contained 0.05 acres of *H. johnsonii*, *H. decipiens*, and *Halodule wrightii*. The 2006 report documents a complete species transition (from *H. wrightii* to *Halophila decipiens*) within one bed along the SAC (see Figure 2). In preparation for the interagency

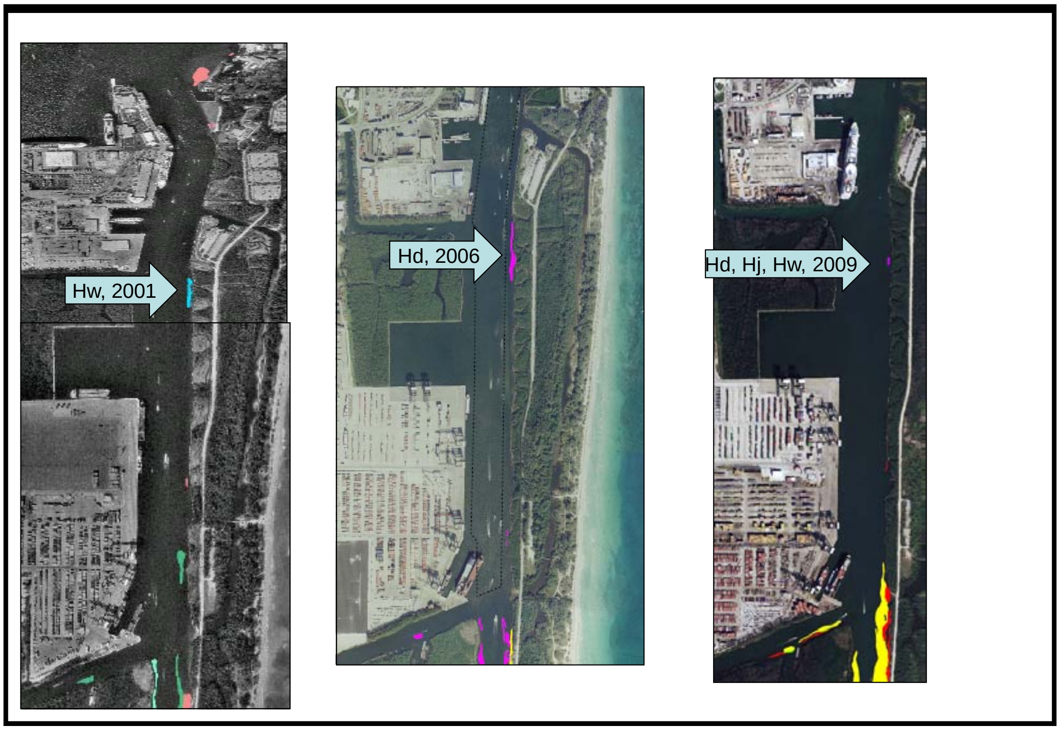
verification survey in 2008, the area was subdivided into three assessment areas, indentified as areas A, B, and C (see Figure 1). The 2008 verification survey did not include Area C. However, the 2008 survey documented a notable increase in seagrass locations along Areas A and B. In 2009, this bed transitioned again to a mixed *H. wrightii*, *Halophila decipiens,* and *H. johnsonii* bed (DCA 2009). The cumulative seagrass acreage is 1.15 acres (Table 3).

Seagrass Assessment Area 6:
This area is not within the current footprint of the proposed project. In 2001, the area contained 0.24 acres of *H. decipiens, H. johnsonii,* and *Halodule wrightii* along the southern side of the DCC. In 2006 the area contained 0.12 acres of monospecific *H. decipiens* along the south side of the DCC. The 2008 verification survey documented a notable increase in seagrass locations along the north and south sides of the DCC. Of particular importance is the documentation of a westward expansion of the *Halophila* species and the expansion of seagrass habitat to the north side of the DCC, in addition to one observation of *Halodule wrightii*. In 2009, *H. johnsonii* and *H. decipiens* were documented along the south side of the channel and *H. johnsonii* along the north side of the channel. In 2009, 0.74 acres of seagrass were documented in this area. The cumulative acreage in this area is 1.01 acres (Table 3).

In 2009, the survey geographic scope did not include transects in the entire western seagrass expansion area (DCA 2009). On July 31, 2009, NMFS and FWC attempted to conduct a seagrass survey west of the Port Everglades project area associated with the review of a separate project proposed by the Florida Inland Navigation District. However, biologists were unable to complete the survey because the bottom was covered in cyanobacteria. NMFS swam along the Port Everglades project survey area (on the south side of the DCC) and observed similar conditions. Cyanobacteria blooms are common in this area and appear to correlate with periods of warm water, freshwater inputs, and increased nutrient inputs from upstream of the DCC (Ryan St. George, personal communication, Broward County Department of Environmental Protection and Growth Management, 2009).

Seagrass Assessment Area 7:
Similar to assessment area 6, this area is not within the current footprint of the proposed project. This area is located along the AIWW south of the DCC. This was the only area where seagrass was documented along the western side of the AIWW. In 2001 the area contained 4.11 acres of mixed *H. johnsonii, H. decipiens,* and *Halodule wrightii,* however *Halodule wrightii* was only observed along the east side of the AIWW. In 2006, the area contained 2.67 acres of *H. johnsonii* and *H. decipiens.* Based on the 2008 verification survey, it did not appear that conditions have changed much in this area, except for the channel-ward migration of a *H. johnsonii* bed along the east side of AIWW. In 2009, the area contained 7.11 acres of *H. johnsonii, H. decipiens,* and *Halodule wrightii.* Similar to 2001, the *Halodule wrightii* was only observed along the east side of the AIWW. Another notable change is that the west side of the AIWW only contained *H. decipiens* and in all previous years, *H. johnsonii* was also observed along the west side of the AIWW. The cumulative seagrass acreage is 7.92 acres (Table 3).

Figure 2: 2001 to 2009 species transition along SAC From left to right, DCA 2001 (Figures 8-9), and DCA 2006 (Figure 4), and DCA 2009 (Figure 5). Hw = *Halodule wrightii*; Hd = *Halophila decipiens*; Hj = *H. johnsonii*



2.3 Cumulative seagrass area assessment from 2001 to 2009

A GIS was used to examine the changes in seagrass coverage between 2001, 2006, and 2009. NMFS determined that the 2001 report documented 9.70 acres[1] of seagrass; the 2006 report documented 8.44 acres of seagrass; and the 2009 report documented 11.98 acres of seagrass. The latter two reports did not survey the OEC. Based on this analysis, the cumulative seagrass coverage in the Port Everglades area is 19.45 acres (Table 3).

3. Mangroves

3.1 Review of literature, related information, and views of recognized experts on the habitat or species that may be affected

Mangrove habitats are ecologically important coastal ecosystems (Lugo and Snedaker 1974). Mangrove wetlands in the Port Everglades project area provide a buffer against storm surges, reduce shoreline erosion and turbidity, absorb and transform nutrients, and are inhabited by a variety of organisms, including various life stages of federally managed fishes. Mangrove habitats provide shelter for larval, juvenile and adult fish and invertebrates, in addition to contributing dissolved and particulate organic

[1] We note that the acreage listed in the 2001 report does not include the OEC seagrass bed and the acreage provided for two polygons exceeds the square feet, resulting in a net difference of 0.047 acres.

detritus to estuarine food webs. Because of this linkage, both as habitat and as food resources, mangroves are important exporters of material to coastal systems as well as to terrestrial systems. Mangroves help shape local geomorphic processes and are important in the heterogeneity of landforms which provide shelter, foraging grounds and nursery areas for terrestrial organisms. The root system binds sediments thereby reducing sedimentation to nearby habitats and contributing to sediment stabilization. Mangrove communities support mobile components, most of which, from a fisheries standpoint, interact with the community during flood tides (Gilmore and Snedaker 1993). Transient representatives typically are represented by larval and juvenile stages of both invertebrates and fish commonly found using the fringe and overwash island mangrove forests, and frequently the adult stage is found in adjacent seagrass meadows or in reef structures.

Mangrove habitats provide nursery habitat, feeding and growth, and refuge for both recreationally and commercially important fishery organisms and their food resources when flooded. It has long been recognized that mangrove habitats in the southeastern U. S. are important to fishery resources (Odum 1988; Gilmore and Snedaker 1993). Mangroves are important for the growth and development of many marine fishes and there is a high dependence of juveniles on mangroves as nursery areas (Baelde 1990; Rooker and Dennis 1991; Nagelkerken et al. 2000; Mumby et al. 2004).

Worldwide, mangrove ecosystems have declined by approximately 35 percent (Valiela et al. 2001). In Florida, where most U.S. mangroves are located, current mangrove coverage represents a significant reduction from coverage that existed 100 years ago (Gilmore and Snedaker 1993). Specifically, in southeast Florida (Monroe to Martin counties) mangrove acreage declined 11% from 1987 to 2000 (Ueland 2005). Nearshore mangrove habitats along the southern Florida coast also contribute substantially to regional reef fish resources, which also supports a tourist industry and recreational and commercial fisheries valued in billions of dollars (Bohnsack and Ault 1996). Mangrove habitats directly benefit the fishery resources of estuaries and coral reefs within and adjacent to Port Everglades and the Atlantic Ocean by providing nursery habitat. The cumulative loss of these habitats continues to reduce fisheries production within Florida waters.

3.1.1 Ecological function of mangroves and mangroves as EFH

The SAFMC designated mangroves as EFH-HAPC for species managed under the snapper-grouper FMP. Federally managed species documented in the Port Everglades expansion area and associated with mangrove habitat include bluestriped and French grunts; and gray and mutton snappers. Other snapper-grouper species known to utilize mangrove habitat include goliath grouper. Additionally, species managed under the highly migratory species FMP, such as nurse (*Ginglymostoma cirratum*) and lemon (*Negaprion brevirostris*) sharks exhinit an affinity for mangrove habitats. See Table 1 for a list of species associated with mangrove habitat and documented in the project area.

A few studies have quantified fishes within mangroves of southeast Florida. In a study located south of Port Everglades, Thayer et al. (1997) found 36 species exclusively in mangroves, 24 species in adjacent seagrass, 27 species in both habitats, thereby yielding a total of 63 species for mangroves in study sites that ranged in area from 21.7 to 58.2 m^2 (233.6 to 626.5 ft^2). In a study within the Indian River Lagoon, located north of Port Everglades, Gilmore (1995) sampled estuarine mangroves over a period of more than 20 years, and recorded 88 species of fish. Spiny lobsters and pink shrimp are the most important commercial and recreational invertebrates commonly found among the prop roots of red mangroves (*Rhizophora mangle*). However, important links in the trophic structure, i.e., the amphipods, isopods, polychaetes, etc., are also prominent invertebrate components of the mangrove prop-root habitat. Snook (*Centropomus undecimalis*), goliath grouper, tripletail (*Lobotes surinamensis*), leatherjack (*Oligoplites saurus*), gray snapper, dog snapper, sailor's choice (*Haemulon parra*), bluestriped grunt, sheepshead (*Archosargus probatocephalus*), black drum (*Pogonias cromis*) and red drum also are common to this habitat, using it as refuge and as a ready source of food (SAFMC 2009). Recent studies have documented that juvenile goliath grouper exhibit high site fidelity for mangroves and that mangrove habitats clearly fulfill an important nursery function for this species (Koenig et al. 2007; Frias-Torres 2006).

In particular, studies from southeast Florida highlight the importance of mangrove habitat for gray snapper (Luo et al. 2009) which have been documented in fish surveys conducted for Port Everglades expansion planning (DCA 2001; DCA 2006). For all life stages, mangroves are daytime resting areas for fish, thereby providing protection from predation (Luo et al. 2009). Mangroves are generally vacated at night as individuals forage in adjacent seagrass beds (Rooker and Dennis 1991; Nagelkerken et al. 2000). After foraging, gray snappers return to and shelter in resting schools in complex habitats such as mangrove prop roots (Rooker and Dennis 1991). Luo et al. (2009) also observed high densities of large (>25 cm), mature fishes, suggesting that mangrove habitats also serve as staging areas for adult congregation prior to seasonal spawning migrations to offshore reefs (Sheridan and Hays 2003).

Mangrove tidal creeks and ditches, similar to the habitat located in assessment area 2 (Figures 3 and 4), are not well-studied (Gilmore and Snedaker 1993), but based on the limited data are also utilized extensively by fishery organisms (Valentine-Rose et al. 2007; Krebs et al. 2007). Large aquatic predators appear to enter this mangrove community through the tidal tributary habitat. In particular, tarpon (*Megalops atlanticus*) is found in mangrove creek habitat. Because this habitat type (at least the creek edges) is flooded most of the time, this can serve as habitat for both resident and transient species. Predaceous fishes common to this mangrove habitat are juvenile bull sharks (*Carcharhinus leucas*), Atlantic stingray (*Dasyatis sabina*), ladyfish (*Elops saurus*), snook, goliath grouper, gray snapper and red drum. Turtles, crocodiles, and alligators also forage in these habitats (SAFMC 2009).

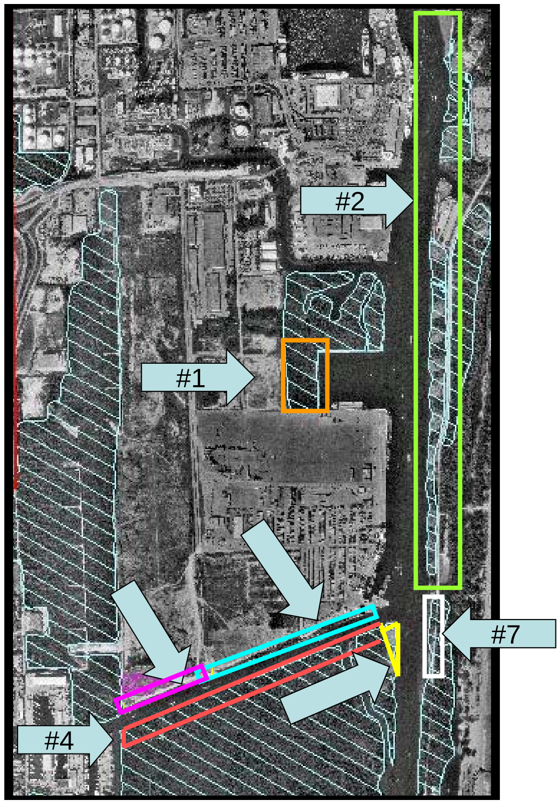
The mangrove basin habitat, similar to the habitat located within the westernmost edge of the Turning Notch (Figure 3, area 1), generally supports a less complete community and may be subject to higher environmental stresses due to seasonal changes in water and thus availability for fishery resources. The more abundant fishes found in this habitat type are cyprinodontiform species such as eastern mosquitofish (*Gambusia holbrooki*) and sailfin molly (*Poecilia latipinna*). These species do provide food resources for surrounding habitats during periods of flooding when there is exchange with the adjoining estuary or riverine system (SAFMC 2009).

The prevailing paradigm regarding food webs of mangrove-dominated estuarine ecosystems is that they are based on particulate mangrove detritus, but research indicates that the dissolved organic form may be equally important (SAFMC 2009). Each habitat type may export organic matter that generates chemical cues regulating the presence or absence and abundance of estuarine organisms and thus, the predictable spatial and temporal patterns of marine life. For example, Huijbers et al. (2008) showed how post-larval French grunts prefer mangrove waters over coral reef waters. Determining the types and numbers of organisms that exploit these habitats, the functional aspects of habitat use, and how mangrove organic matter is transferred to higher trophic levels is critical, and are requisites for modeling linkages between variations in mangrove productivity and variations in faunal abundances. Mangroves may influence nutrient dynamics and associated coastal productivity by either removing or contributing nutrients to these systems, and data on their function in maintaining water quality of estuarine ecosystems are limited (SAFMC 2009).

3.2 Review of available surveys

NMFS characterized seven mangrove assessment areas that were defined based on similarities in water depth, water quality and clarity, and landscape position (Figure 3). A summary of each assessment area is provided below and is based on based on information provided in DCA 2001 and one interagency field inspection on May 6, 2008. Field notes from an interagency Estuarine Wetlands Rapid Assessment Procedure conducted in 2001 are also summarized in relevant sections. DCA (2001) characterized five mangrove areas in the Port Everglades area, generally referred to in Figure 3 as assessment areas 1, 2, 3, 4, and 7. In 2008, NMFS observed mangroves along the northern side of the DCC (identified in Figure 3 as assessment areas 5 and 6).

Figure 3: Mangrove Assessment Areas (modified from DCA 2001). Hatching indicates mangrove habitat and numbered arrows point to assessment areas identified by colored polygon.



No dredging is currently proposed by the Jacksonville District in assessment areas 1, 3, 4, 5, 6, and 7; however the Port may request separate authorizations to dredge these areas. Therefore the assessment areas are included; this approach is consistent with the Council on Environmental Quality's recommendations for describing the affected environment (CEQ 1997). In addition, this information has relevant context because the federally managed fish move among these habitats and adjacent habitats.

Mangrove Assessment Area 1 (also referred to as the Turning Notch)

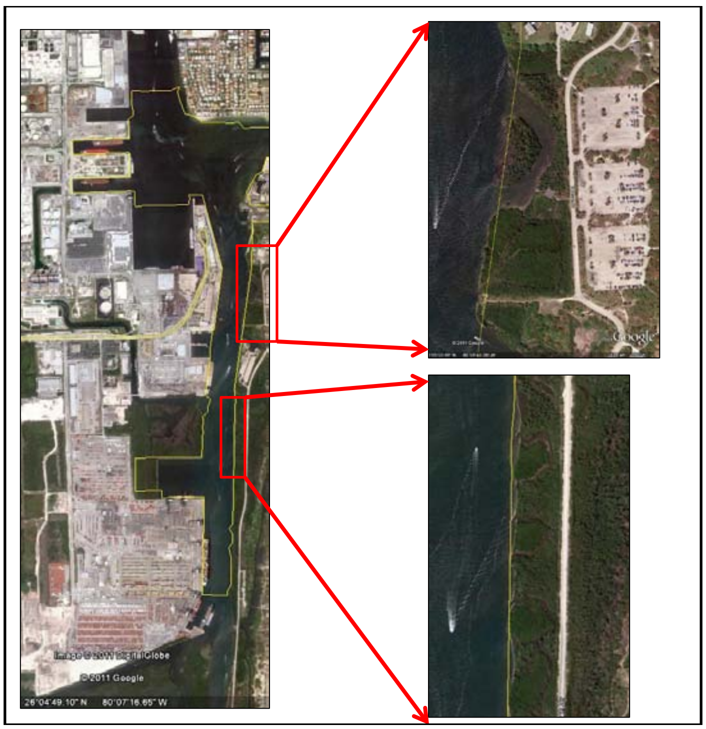
This 8.7-acre area is known as the Turning Notch mangrove assessment area. Fish and Wildlife Service field notes from the Estuarine Wetland Rapid Assessment Procedure (FWS 2001) noted mature and "pure" red black (*Avicennia germinans*), and white (*Laguncularia racemosa*) mangroves in this area. This mangrove area is mitigation for previous wetland impacts associated with the Turning Notch Project (DCA 2001). During the interagency site visit in May 2008, it was noted this area contains a mature mangrove community and the riprap revetment between the mangroves and open water appears to provide sufficient spacing to allow for detrital exchange and fishery resource access.

Mangrove Assessment Area 2

This area is the only mangrove habitat area contained within the current expansion area. This area contains narrow fringes of mangroves, well-developed mangrove wetlands, a mixed mangrove tidal creek, and oxbow features. The area is located within John U. Lloyd State Park and south of the U.S. Coast

Guard station along the east side of the AIWW (Figure 3). The northern portion of this assessment area was visited on May 6, 2008, during an interagency field inspection that characterized this area as beach sand with a narrow fringe of mangrove (approximately one tree deep). The southern portion of this mangrove area contains a well-developed mangrove wetland with tidal creeks and oxbows (Figure 4). Some of the mangrove habitat in this assessment area is mitigation for previous wetland impacts associated with the Turning Notch Project in the mid-1990s (DCA 2001). Approximately 23 acres of mangroves were planted along the eastern edge of the AIWW at John U. Lloyd State Park for mitigation associated with the Turning Notch Project, however they were not placed under a conservation easement, as they were on state owned land (DCA 2001).

Figure 4: Mangrove and Tidal Creek Habitat Within and Adjacent to Port Everglades Expansion Area. The yellow line indicates limit of proposed dredging.



Mangrove Assessment Area 3 (also referred to as the Salina Assessment Area)

This is the easternmost polygon along the south side of the DCC. This area was separated from area 4 because it appears to be functioning more as a salina (or salt flat), than as a mangrove community. NMFS and other agencies assessed this area on May 6, 2008, and characterized this area as a triangular shaped spoil area. It is appears to be at a higher elevation than mangroves to the south. The area is surrounded by riprap 1 to 2 m (3 to 6 ft) wide that becomes patchy towards the south along the DCC. Red and black mangroves are present along the shoreline and there are little to no invasive, non-native plant species in this area.

Mangrove Assessment Area 4

This area is located along the southern side of the DCC and has riprap along the shoreline. This area is characterized as actively eroding (Broward County West Lake Park, Conceptual Master Plan C 2001). This was verified during the field inspection in May 2008. Specifically the frequent large vessel traffic and associated large wakes are thought to contribute to the erosion. This area is characterized as supporting a mature red mangrove community (FWS 2001). This was confirmed by agencies during a field visit in May 2008. In addition, biologists noted that the red mangroves just beyond the eroded zone seem relatively stable and are tidally influenced.

Mangrove Assessment Area 5
The only available information for this area is from an interagency field inspection in May 2008. This area is located along northwestward side of DCC. A fence exists between assessment areas 5 and 6. This area is characterized as red, black, and white mangroves and is tidally influenced. Fringes are 3 to 5 m (9 f to 15 ft) wide in some areas; 1 to 2 m (3 to 6 ft) wide in other areas. The shoreline generally contains riprap and the boulders vary in size. This area has some infestation of exotic invasive species, including Australian pine (*Casuarina equisetifolia*) and Brazilian pepper (*Schinus terebinthifolius*).

Mangrove Assessment Area 6
This area is along northeast side of the DCC and supports black and white mangroves; a few red mangroves are also present – generally along the eastern site of this area. The landward portions of this area are tidally influenced. The shoreline contains riprap and the boulders vary in width and size. This area has some infestation by Australian pine and Brazilian pepper. The area between the bulkhead to the east and a riprap wall is devoid of mangroves. There is also a "fill area" that is devoid of vegetated shoreline resources.

Mangrove Assessment Area 7
DCA (2001) depicts this area as a "fringing mangrove." No other habitat characterization is available for this area, however the mangroves appear to be tidally influenced.

4. Soft bottom habitats as EFH

Soft bottom habitat is the area with unconsolidated sediment that lacks vascular plants (i.e., no seagrass is present, but macroalgae may be present). Within the interior portions of Port Everglades, the unconsolidated sediments are usually sand, silty sand, or mud with sandy material occurring more commonly in shallow waters and near the inlet and muddy sediments occurring in deepwater waters and towards the Dania Cutoff Canal. Although soft bottom habitat lacks visible structural features, many microscopic plants occur at the sediment surface and burrowing animals commonly occur below the surface (Peterson and Peterson 1979; Alongi 1990); the dominant taxa of macroinfauna are usually polychaetes, crustaceans, mollusks, and echinoderms. One of the more interesting features of soft bottom communities is that the species within this habitat can significantly structure the habitat through processes, such as bioturbation, enhancing water flow through sediments, and tube building, that affect community as a whole. Similarly, soft bottom habitat provides important ecological services to coastal ecosystems (Peterson and Lubchenco 1997). For example, soft bottom areas serve as a storage reservoir of chemicals and microbes. Intense biogeochemical processing and recycling establish a filter to trap and reprocess watershed-derived natural and human-induced nutrients and toxic substances.

One of the more important services provided by soft bottom habitat is foraging habitat for fishery species and their prey. For example, adult white grunts, which are a federally managed fishery species as well as an important food source for species managed within the snapper-grouper complex, are generalized carnivores that feed mainly on benthic invertebrates (Bowman et al. 2000; Potts and Manooch 2001). The high forage value of soft bottom habitat results from the high concentrations of organic matter transported to and produced on soft bottom and the numerically abundant, diverse invertebrate fauna associated with this habitat. While the forage value of soft bottom habitat can vary greatly with position in the landscape, proximity to physical disturbance (such as dredging and wave scour) and chemical disturbances (such as stormwater runoff and low concentrations of dissolved oxygen) can be overriding factors (Pearson and Rosenberg 1978; Diaz and Rosenberg 1995).

Soft bottom habitat also can provide refuge to smaller organisms, such as juvenile fish, because predators are unable to maneuver effectively in shallow waters (Ross and Epperly 1985). Consequently, juvenile fish typically first recruit to the shallowest portions of an estuary or lagoon. Flounder, rays (e.g., *Urobatis jamaicensis* or *Dasyatis americana*), and small cryptic species, such as pink shrimp and blue crabs, can bury in the sediment, camouflaging themselves from predators. Smaller predators in shallow water and larger predators in deeper water also bury themselves in soft bottom habitats relying upon ambush tactics for feeding (Walsh et al. 1999). Consequently, many fish, crabs, and shrimp in subtidal, soft bottom habitats forage nocturnally (Summerson and Peterson 1984).

The high availability of food coupled with the refuge for predators make soft bottom habitats, especially those in shallow waters and those close to mangroves, seagrass, live/hardbottom, or inlets, important nursery areas for many species of juvenile fish. Much of the soft bottom habitat within Port Everglades is near one of these habitats (Figures 1 and 4). Only a few studies have been done of the soft bottom habitat within the interior portion of the port. DCA (2001) summarizes those studies: Rudolph (1986) and Messing and Dodge (1997) identified 370 species of invertebrates within the shallow water benthic community, including polychaetes, oligochaetes, mollusks, sipunculids, peracarid crustaceans, platyhelminthes, and nemertina. While these studies did not sample the deeper areas (i.e., the federal navigation channel or turning basins) it is likely the deeper areas have lower abundances and diversity than the shallower areas. The offshore soft bottom communities located within the study area include polychaete and other worms. In an infaunal study conducted offshore of Hollywood Beach, Dodge et al. (1991) found dominant taxa were polychaetes (52 percent), nematodes (14 percent), and crustaceans (9 percent). Offshore soft bottom habitats within the study area, in particular between the Middle and Outer Reefs, may provide a corridor for reef species to travel between reef lines and also be an important foraging area for some fish species (Jones et al. 1991).

The SAFMC designated soft bottoms as EFH for species managed under the snapper-grouper, shrimp, and spiny lobster FMPs. Federally managed species documented in the Port Everglades expansion area and associated with soft bottom habitat include white grunt, pink shrimp, and spiny lobster. Additionally, species managed by NMFS under the highly migratory species FMP, such as Atlantic sharpnose, bonnethead (*Sphyrna tiburo*), and finetooth (*Carcharhinus isodon*) sharks have an affinity for soft bottom habitats. See Table 1 for a list of species associated with soft bottom habitat and documented in or near the project area.

5. Port Everglades Inlet as EFH

Tidal inlets are HAPCs because of the unique role they play as migratory corridors connecting ocean and estuarine waters that serve as spawning and nursery areas for shrimp, red drum, mackerels, and other species (Hettler and Chester 1990; Lindeman et al. 2000; Faunce and Serafy 2007; Serafy et al. 2007). It should be noted that habitats, such as seagrass beds, mangroves, hardbottom, coral, and coral reefs, also are HAPCs, and this close proximity emphasizes this important linkage role for this particular inlet.

Movement of larval and juvenile fish and shrimp through inlets can vary greatly between inlets and over time with some species migrating nocturnally, within portions of the tidal stream, phases of the lunar cycle or interaction of these factors (Forward et al. 1999). The major point being that migration through inlets rarely is a passive process and, instead, reflect behaviors of the migrants. While modeling studies conducted for this project and summarized in this Draft EIS conclude that changes in the physical characteristics of Port Everglades Inlet as a result of dredging will be minor, these studies do not examine the response of fish and other organisms to those changes, and such examinations would be difficult to do. Most larval and juvenile fish that utilize the inlet to access their inshore nurseries respond to a variety of environmental factors once they reach the inlet (Boehlert and Mundy 1988). Dredging of inlets, including their ebb and flood tide shoals, may result in unanticipated changes to the cues used by migrants to the estuary. Species that orient to cues associated with the sea bottom may be affected by a deepened channel. Channel dredging also may change flow of long-shore currents. These currents not only affect the transport of sediments along the beach but also influence the recruitment of early life history stages of fish and invertebrates into the estuary. In short, complex modeling and empirical studies would be needed to examine how fish would respond to the modified inlet.

The SAFMC designated coastal inlets as EFH for species managed under the snapper-grouper and shrimp FMPs. Additionally, the Mid-Atlantic Fishery Management Council designated coastal inlets as EFH in the bluefish (*Pomatomus saltatrix*) FMP.

6. Hardbottoms, coral, and coral reefs

6.1 Review of literature, related information, and views of recognized experts on the habitat or species that may be affected

The coral reef system off southeast Florida is a continuation of the Florida Reef Tract and extends approximately 170 km (150 mi) from the border of Biscayne National Park to the south to the St. Lucie Inlet to the north (Collier et al. 2008; Banks et al. 2007; Walker et al. 2008a). The southeast Florida reef system runs parallel to the coast for approximately 500 km (310 mi) from the Dry Tortugas in the south to Martin County in the north. The biological communities living on these high-latitude coral reefs consist of typical Caribbean fauna (Goldberg 1973; Moyer et al. 2003). Offshore Fort Lauderdale, Florida (Broward County) and closest to shore in water depths less than 4 m (12 ft), nearshore hardbottoms are part of a ridge complex and separated in a cross-shore direction by expanses of sand, landward of the coral reefs. Offshore Fort Lauderdale there are generally three lines of coral reef; Inner Reef crests in 3 to 5 m (9 to 15 ft), Middle Reef crests in 7 to 9 m (21 to 27 ft), and Outer Reef crests in 16 to 23 m (48 to 69 ft) water depths (Banks et al. 2007; Walker et al. 2008a). Nearshore of the Inner Reef is a series of nearshore ridges and sand (Moyer et al. 2003; Banks et al. 2007; Walker et al. 2008a).

The coral reef-associated communities in the southeast Florida region are tropical to subtropical in species composition with a fauna and flora similar to the Florida Keys and wider Caribbean. Some faunal differences occur along the Florida Reef Tract in response to water temperature ranges, substrate availability, and other variables (SAFMC 2009), which may affect the abundance of species. A major contributor to coral reef ecosystems is often coral itself, since the corals provide habitat and food for most of the other members of the ecosystem (SAFMC 2009).

The status of coral, coral reef, and live/hardbottom community habitats in southeast Florida have mostly been recorded as part of monitoring efforts (Gilliam et al. 2010; Gilliam 2010) originating as impact and mitigation studies from human activities to specific sites (dredge insults, ship groundings, pipeline and cable deployments, and beach renourishment). Scleractinian coral density is generally 2 to 3 colonies/m^2 and coverage generally 2 to 3%. Much of scleractinian coral cover in this region is less than 1% but several nearshore areas have coverage greater than 10%. The largest known coral colonies in Broward County are large *Montastrea faveolata* colonies ranging from 2 to 4 m in diameter and older than 300 years. These corals are documented on the shallow colonized pavement and nearshore ridges. Coral coverage on these habitats may reach up to 40% or higher in this habitat type (Walker et al. 2008b). Over 30 scleractinian coral species have been identified in southeast Florida with common species including *Montastrea cavernosa*, *Siderastrea siderea*, *Porites astreoides*, and *Stephanocoenia intersepta* (Gilliam et al. 2009). The aforementioned species have also been documented in the Port Everglades expansion area (Tables 1 and 4). Octocorals are generally more abundant that scleractinian corals in this region. Density can approach 20 colonies/m² with coverage of 20% (Gilliam et al. 2010). Much less data exist on the species richness due to the difficulty of field identification, but common species include several *Eunicea* species, *Eunicea flexuosa*, *Pseudopterogorgia americana*, and *Muricea muricata*, all (genera) of which have been documented in the Port Everglades expansion area (Tables 1 and 4). Additionally, southeast Florida (especially offshore Broward County) has a number of unique and extensive staghorn coral, *Acropora cervicornis*, patches. These patches have measured coverages greater than 30% (Gilliam et al. 2010). Under the Endangered Species Act, the Jacksonville District will consult with NMFS on potential effects to threatened elkhorn (*A. palmata*) and staghorn coral from the proposed action, however it is important to note that elkhorn and staghorn coral, like other coral species and the associated hardbottom habitat, are also designated as EFH-HAPC.

The SAFMC designates coral, coral reef, and hardbottom habitats as EFH-HAPC for species managed under the snapper-grouper, spiny lobster, and coral, coral reef, and live/hardbottom FMPs. Additionally, sponge habitats are designated EFH-HAPC for the spiny lobster FMP. All demersal fish species under SAFMC management that associate with coral habitats are contained within the FMP for snapper-grouper species and include some of the more commercially and recreationally valuable fish of the region. All of these species show an association with coral or hardbottom habitat during their life history. In groupers, the demersal life history of almost all *Epinephelus* species, several *Mycteroperca* species, and all *Centropristis* species, takes place in association with coral habitat (SAFMC 2009). Coral, coral reef, and hardbottom habitats benefit fishery resources by providing food or shelter (SAFMC 1983).

Federally managed species with affinity to coral, coral reef, and hardbottom habitat include several species of snappers from the genus *Lutjanus* (including the juvenile gray snapper), yellowtail snapper, gray triggerfish, various species of grunts from the genus Haemulon, bar jack (*Caranx ruber*), graysby (*Epinephelus cruentatus*), red grouper, and coney (*Cephalopholis fulva*). All of the aforementioned species were identified in fish surveys completed for Port Everglades expansion planning (see DCA 2001; DCA 2006). Other federally managed species that utilize coral, coral reef, and hardbottom habitat in waters offshore Broward County include scamp (*Myceteroperca phenax*), gag, bank seabass (*Centropristis ocyrus*) and almaco jack (*Seriola rivoliana*). Ferro et al. (2005) documented these species in marine waters offshore Broward County in addition to 204 other species of fish. Additionally, species managed by NMFS under the highly migratory species FMP, such as lemon and nurse sharks have an affinity for coral reef habitats. See Table 1 for a list of species associated with coral, coral reef or live/hardbottom habitat and documented in the project area.

Table 4: Corals documented in Port Everglades Field Studies. Type of scleractinian coral also noted.

Scleractinian				**Octocorals**
massive	**brooder**	**branching**	**other**	**genera**
Colpophyllia natans	*Agaricia agaricites*	*Acropora cervicornis* [1]	*Leptoseris cucullata*	*Briareum*
Dichocoenia stokesii	*Agaricia lamarcki*	*Porites porites*	*Phyllangia americana*	*Ellisella*
Diploria clivosa [2]	*Porites astreoides*			*Erythropodium*
Diploria labyrinthiformis	*Siderastrea radians*			*Eunicea*
Diploria strigosa				*Iciligorgia*
Eusmilia fastigiata				*Muricea*
Madracis decactis [3]				*Muriceopsis*
Madracis pharensis [2,3]				*Plexaura*
Manicina areolata				*Plexaurella*
Meandrina meandrites				*Pseudoplexaura*
Montastraea annularis				*Pseudopterogorgia*
Montastraea cavernosa				*Pterogorgia*
Mussa angulosa				
Mycetophyllia aliciae				
Mycetophyllia ferox				
Mycetophyllia lamarckiana				
Scolymia spp.				
Siderastrea siderea				
Solenastrea bournoni				
Solenastrea hyades				
Stephanocoenia intersepta				

All species documented in DCA 2006, except:

[1] from DCA 2001
[2] from FDEP 2008

[3] Branch morphology as well

6.2 Review of Available Coral Reef Surveys

Five survey reports are available that map and characterize the coral reef and hardbottom habitats within the Port Everglades project area (Table 5). In 2000 and 2001, a towed underwater video approach was used to record hardbottom and coral reef habitats along the Port Everglades project area. Additional video and field data were collected to assess the accuracy of the maps. This effort is described in DCA (2001). Additionally, in February and March 2006, contractors for the Jacksonville District assessed coral reef habitats along the Middle and Outer Reefs within the Port Everglades project area. The findings from this effort are provided in DCA (2006). Additionally, in 2006, representatives from FDEP conducted a separate field inspection of the Outer Reef and portions of the Middle Reef channel wall. In 2007, representatives of FDEP visited portions of the Inner Reef channel wall. Results are reported in FDEP (2007). Finally, as part of a separate project Gilliam and Walker (2008) surveyed the rubble shoal and portions of the channel wall.

Table 5: Coral reef and fish surveys conducted in the Port Everglades area between 2001 and 2008

Study reference	Date	Spatial Scope of Survey
DCA 2001	1999 to 2001	Port Expansion and nearby areas
Ferro et al. 2005	1998 to 2002	Offshore Broward County
DCA 2006	2006	Middle and Outer Reef
FDEP 2007	2006 and 2007	Channel wall, Outer Reef
Gilliam and Walker 2008	2008	Channel wall and rubble shoal

Seven distinct hardbottom and coral reef habitat types are present within the Port Everglades project area. These include the Outer Reef, Middle Reef, Inner Reef, channel wall, nearshore hardbottom, rubble shoal, and submerged breakwater (see Figure 5). Each of these habitat types are described below based on available survey information. The nearshore hardbottom, rubble shoal, and submerged breakwater are grouped together based on how they are described in the available information. Based on the 5 available survey reports, 29 species of scleractinian corals and 12 genera of octocorals have been documented in the Port Everglades expansion area (Table 4). Species listed are representative of the Port Everglades project area, however notably absent from DCA (2006) are octocorals of the genus *Gorgonia* and the barrel sponge *Xestospongia muta*, which are a dominant fauna component of the coral reefs off southeast Florida, including the Middle Reef. Also notably absent in the surveys conducted by DCA (2001 and 2006) are scleractinian corals larger than 50 cm in diameter within the Middle Reef and Outer Reef. Representative photos of a subset of species from field efforts are provided in Figure 6.

<u>Outer Reef</u>

Seventeen scleractinian coral species and 12 octocoral genera have been documented in the Outer Reef areas within and adjacent to planned Port expansion (DCA 2006). Overall scleractinian colony density ranged from 1.4 to 2.2 colonies/m² and octocoral density ranged from 0.1 to 1.7 colonies/m². At the time of the survey conducted by DCA in 2006, they estimated coral densities and determined that 60,882 scleractinian corals and 47,206 octocorals were located within the direct impact area of the Outer Reef. Barrel sponges were observed in highest densities at Outer Reef sites (0.2 colonies/m²). Corals of the Outer Reef were qualitatively described as healthier (compared to the Middle Reef) and less than 3% of the corals showed evidence of poor colony condition, such as paling, bleaching, or partial mortality (DCA 2006).

DCA (2006) grouped corals into 4 size classes I = 0 to 3 cm; II = 4 to 10 cm; III = 11 to 25 cm; IV = 26 to 50 cm (Table 6). At the time of the survey conducted in 2006, DCA estimated that most of the scleractinian corals were in size class II, however they reported corals in all other size classes (Table 6). They did not observe corals greater than 50 cm along the survey transects. However, during a FDEP field inspection on October 18, 2006, biologists observed corals greater than 50 cm in diameter along the Outer Reef within the Outer Entrance Channel seaward extension area (FDEP 2007). Direct impact (dredging) area estimates for the Outer Reef range from 6.9 ac (DCA 2006) to 13.5 ac (Walker et al. 2008b). The amount of Outer Reef within the 150 m indirect impact zone is approximately 28.3 ac (Walker et al. 2008b) (Table 7).

Table 6: Distribution of scleractinian colony size by species, reef, and zone, as encountered in visual belt transects off Port Everglades in March 2006. Sizes were organized in four size classes: Class I = 0 to 3 cm; Class II = 4 to 10 cm; Class III = 11 to 25 cm; Class IV = 26 to 50 cm [R=Reef; Z=Zone; PI=Previously Impacted; C=Control]. From DCA 2006.

	R2-Z1				R2-Z2				R3-Z1				R3-Z2				R3-Z3			
	I	II	III	IV	I	II	III	IV	I	II	III	IV	I	II	III	IV	I	II	III	IV
Agaricia agaricites	0	1	0	0	0	0	0	0	1	2	1	0	0	0	1	0	1	5	2	0
Agaricia fragillis	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Agaricia humilis	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Agaricia lamarcki	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0
Colpophyllia natans	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0
Dichocoenia stokesii	0	1	0	0	0	0	0	0	3	1	0	0	5	3	0	0	0	2	0	0
Diploria labyrinthiformis	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Diploria strigosa	0	0	2	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0	1
Eusmilia fastigiata	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Favia fragum	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Leptoseris cucullata	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Madracis decactis	0	0	1	0	0	4	0	0	2	2	1	0	0	4	5	0	2	5	4	0
Manicina areolata	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Meandrina meandrites	0	1	2	0	0	1	1	0	2	3	2	0	2	4	0	0	0	5	2	0
Montastraea annularis	2	3	0	0	0	3	4	0	1	1	0	0	0	0	0	0	0	1	4	0
Montastraea cavernosa	0	4	2	1	1	6	4	0	12	26	16	0	8	13	2	0	11	12	5	0
Mycetophyllia aliciae	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	0	0	0	0
Mycetophyllia ferox	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0
Porites astreoides	0	3	0	0	0	7	1	0	9	61	13	0	2	18	0	0	1	28	18	2
Porites porites	0	0	0	0	0	0	0	0	0	4	1	0	0	1	0	0	1	1	2	0
Scolymia spp.	0	0	0	0	0	0	0	0	1	0	0	0	1	0	0	0	1	0	0	0
Siderastrea siderea	11	8	2	0	8	10	1	0	44	30	1	0	29	23	5	0	24	38	4	0
Siderastrea radians	3	3	0	0	2	3	0	0	13	15	1	0	7	10	1	0	4	8	1	0
Solenastrea bournoni	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0
Stephanocoenia intersepta	3	7	0	0	9	15	2	0	34	24	0	0	29	36	3	0	18	38	6	1

	R3-PI-Z1				R3-PI-Z2				R3-PI-Z3				R3-C-Z1				R3-C-Z2				R3-C-Z3			
	I	II	III	IV	I	II	III	IV	I	II	III	IV	I	II	III	IV	I	II	III	IV	I	II	III	IV
Agaricia agaricites	1	0	0	0	0	1	0	0	0	2	0	0	0	1	1	0	0	0	4	1	1	3	0	0
Agaricia fragillis	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Agaricia humilis	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Agaricia lamarcki	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Colpophyllia natans	0	0	0	0	0	0	0	0	0	0	0	1	0	0	1	0	0	0	0	0	0	0	0	0
Dichocoenia stokesii	1	1	0	0	1	5	0	0	0	5	1	0	2	3	0	0	0	0	1	0	2	2	1	0
Diploria labyrinthiformis	0	1	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Diploria strigosa	0	1	0	0	0	0	0	0	0	0	0	2	0	0	0	1	0	0	0	0	0	0	0	0
Eusmilia fastigiata	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	1	0	1	1	0	0
Favia fragum	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Leptoseris cucullata	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0
Madracis decactis	2	4	2	0	3	6	2	0	3	2	2	0	1	7	0	0	0	2	0	0	1	1	3	0
Manicina areolata	0	0	0	0	1	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Meandrina meandrites	0	2	0	0	1	2	0	0	1	2	0	0	0	2	0	0	0	1	0	0	0	1	1	0
Montastraea annularis	3	1	0	0	0	1	3	1	1	2	5	0	1	1	0	0	0	3	1	0	3	2	1	1
Montastraea cavernosa	11	8	2	0	4	12	8	0	8	8	8	1	6	23	8	2	1	6	8	2	6	12	9	1
Mycetophyllia aliciae	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Mycetophyllia ferox	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0
Porites astreoides	6	47	8	0	1	13	2	0	2	28	3	0	3	48	5	1	1	15	4	0	6	19	7	0
Porites porites	5	3	0	0	0	2	0	0	0	0	0	0	0	6	0	0	2	6	2	0	5	6	1	0
Scolymia spp.	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Siderastrea siderea	44	60	2	0	21	16	1	0	28	25	4	0	8	26	4	0	15	19	3	0	18	21	0	0
Siderastrea radians	10	5	0	0	10	5	0	0	5	12	0	0	3	7	0	0	2	3	0	0	3	4	1	0
Solenastrea bournoni	0	0	0	0	0	0	1	0	0	0	0	0	0	0	2	0	1	1	1	0	0	1	1	0
Stephanocoenia intersepta	30	21	0	0	19	28	1	0	12	34	1	0	10	18	1	1	12	12	2	0	19	32	1	0

Figure 5. Coral Reef Habitat Types within the Port Everglades Expansion Area (from Walker et al. 2008b)

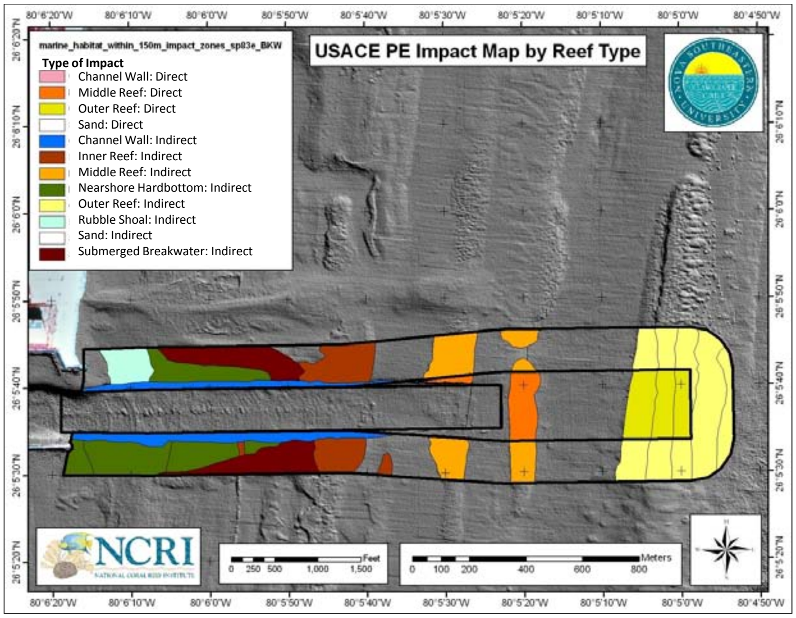


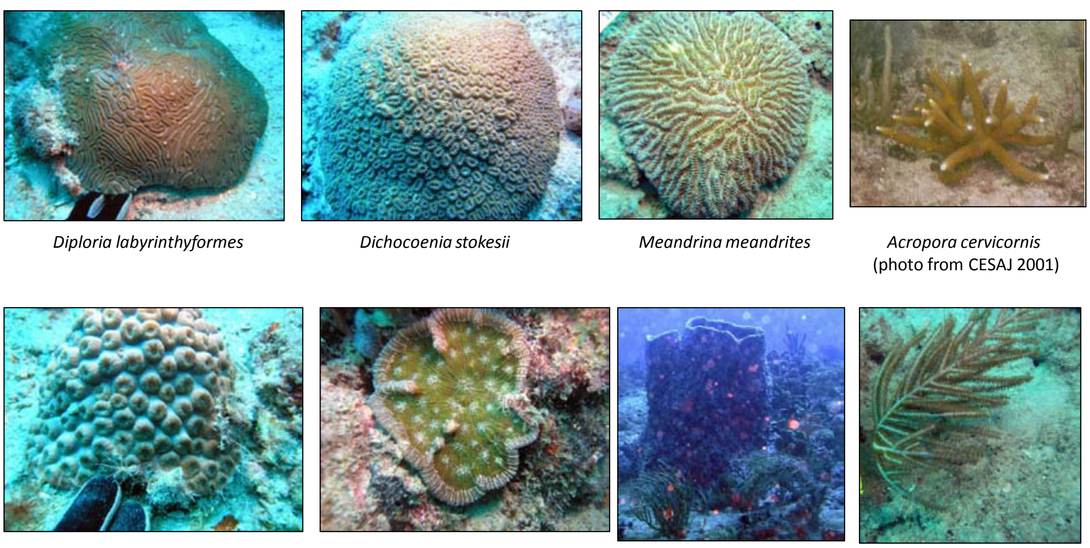
Table 7: Coral Reef Area by Habitat Type (modified from Walker et al. 2008b)

Habitats within dredge area	Type	Modifiers	Area (ft²)	Acres (ac)	Type ac
Coral Reef and Colonized Hardbottom	Outer Reef	Aggregated Patch Reef	301	0.01	13.54
		Spur and Groove	154971	3.56	
		Linear Reef-Outer	180259	4.14	
		Colonized Pavement-Deep	254450	5.84	
	Middle Reef	Linear Reef-Middle	296089	6.80	6.80
Inlet Channel Floor	Inlet Channel Floor	Inlet Channel Floor	2341644	28.59	53.76
Soft Bottom	Sand	Sand	1245485	28.59	28.59
Habitats within 150 m of dredge area					
Coral Reef and Colonized Hardbottom	Outer Reef	Ridge-Deep	178647	4.10	28.26
		Aggregated Patch Reef	257808	5.92	
		Spur and Groove	265158	6.09	
		Linear Reef-Outer	245716	5.64	
		Colonized Pavement-Deep	283893	6.52	
	Middle Reef	Linear Reef-Middle	296089	15.98	15.89
	Inner Reef	Linear Reef-Inner	589069	13.52	13.52
	Nearshore Hardbottom	Colonized Pavement-Shallow	639856	14.69	22.67
		Ridge-Shallow	347739	7.98	
Rubble Shoal	Rubble Shoal	Rubble Shoal	208071	4.78	4.78
Submerged Breakwater	Submerged Breakwater	Submerged Breakwater	748786	17.91	17.91
Inlet Channel Wall	Inlet Channel Wall	Inlet Channel Wall	661113	15.18	15.18
Soft Bottom	Sand	Sand	2413861	55.41	55.41

Middle Reef

Thirteen scleractinian coral species and 9 genera of octocorals have been documented along Middle Reef areas within planned Port expansion (DCA 2006). The overall scleractinian colony density was 0.5 colonies/m² and octocoral density ranged from 0.3 to 0.4 colonies/m². At the time of the survey conducted by DCA in 2006, they estimated coral densities and determined 25,546 scleractinian corals and 24,100 octocorals were located within the direct impact area of the Middle Reef. This area of Middle Reef was qualitatively described as having higher sediment cover, however less than 12% of the corals showed evidence of poor colony condition, such as paling, bleaching, or partial mortality. No barrel sponges were observed (DCA 2006). Direct impact (dredging) area estimates for the Middle Reef range from 11.9 ac (DCA 2006) to 6.8 ac (Walker et al. 2008b). The amount of Middle Reef within the 150 m indirect impact zone is approximately 15.9 ac (Walker et al. 2008b) (Table 7).

Figure 6: Representative photos from Port Everglades Field Studies. (Photo credit: Vladimir Kosmynin, PhD. FDEP 2007, except where otherwise noted)



Diploria labyrinthyformes — *Dichocoenia stokesii* — *Meandrina meandrites* — *Acropora cervicornis* (photo from CESAJ 2001)

Montastrea cavernosa — *Mycetophyllia aliciae* — *Xestospongia muta* — *Pseudopterogorgia*

Channel Wall

Representatives of the FDEP and Broward County visited several sites along the channel wall located along the Middle Reef and Outer Reef on October 18, 2006. Per the FDEP field report, the Middle Reef channel wall is characterized as an artificially created outcrop composed by *Montastraea annularis* framework, which is evidence of middle reef origin. FDEP (2007) states this area is well-flushed with little to no evidence of sedimentation stress. Substrate of wall contains a high diversity of scleractinian coral fauna including *Agaricia agaricities, Montastraea cavernosa, M. annularis, M. faveolata, Meandrina meandrites, Diploria labyrinthyformis, D. strigosa, D. clivosa, Porites astreoides, P. porites, Stephanocoenia intersepta, Eusmillia fastigiata, Dichocoenia stokesii, Madracis* spp., *Mycetophyllia* *ferox, Siderastrea siderea,* and the hydrocoral *Millepora alcicornis.* Coral colonies up to 40 cm in diameter were observed. The wall is also dominated by several species of sponges and encrusting calcareous red algae (FDEP 2007). Notably, the species assemblage is similar to the species list in DCA (2006), however FDEP also observed *Diploria clivosa,* which was not recorded in the DCA (2006) (Table 4).

FDEP (2007) refers to portions of the channel wall that transitions from inside the channel to outside the channel as "channel shoulder". The channel shoulder is characterized as relatively low relief and with fewer species of scleractinian corals, which appear to be of smaller size than on the wall. Scattered octocorals were observed, although octocorals were not observed along the channel wall. Higher levels of sedimentation were observed in this area, which is thought to influence the fauna on the shoulder, especially in lower parts of relief (FDEP 2007).

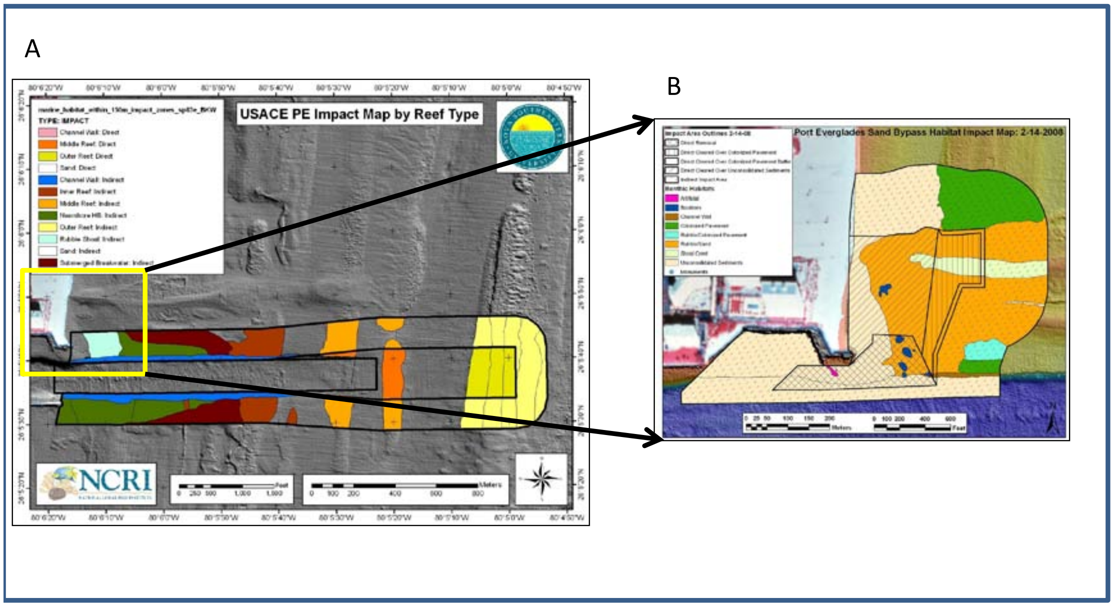
The western portions of the channel wall from the Inner Reef (to the east) have been mapped and characterized separately. FDEP visited the north wall (further west part of the entrance channel in the area of the Inner Reef) in September 2007. The shoulder was observed to be very similar in character to what is described in the Middle Reef and Outer Reef channel wall section, with scattered colonies of *Dichocoenia stokesii, Solenastrea bournoni,* and octocorals. Along the wall overhangs, encrusting colonies of *Madracis* cf. *pharensis* were observed and estimated to be 2 m in diameter. *Madracis pharensis* was not documented in DCA (2006). In addition, Gilliam and Walker (2008) characterized, mapped, and assessed benthic habitats on a portion of the channel wall, located near the Port Entrance (Figure 7). They estimated 1,373 scleractinian corals on the channel wall and shoulder in this area (0.41 acres), with 649 larger than 10 cm in diameter, including one 90 cm diameter *Madracis decatis*. The direct impacts to the channel wall are unclear. The amount of channel wall habitat located within the 150 m indirect impact area is 15.18 ac (Walker et al. 2008b) (Table 7).

<u>Inner Reef</u>
While portions of the Inner Reef were surveyed in 2000 and 2001 by DCA, information in the corresponding survey report does not distinguish between reef areas. However the report notes that the area between the Inner Reef and Middle Reef is characterized by small isolated hermatypic coral heads and interspersed coral rubble, with areas of open sand (DCA 2001). Walker et al. (2008b) described the Inner Reef in Broward County as colonized by coral species with mostly flat growth forms (*Diploria clivosa, Meandrina meandrites*), octocorals, and algae. No direct impacts to the Inner Reef are currently planned through port expansion activities, however 13.5 acres of Inner Reef is located within 150 m of the planned expansion (Walker et al. 2008b) (Table 7).

<u>Rubble Shoal, Submerged Breakwater, and Nearshore Hardbottom</u>
Gilliam and Walker (2008) characterized, mapped, and assessed benthic habitats on a portion of the area referred to as the "rubble shoal". There is overlap with the Port Everglades OEC expansion (Figure 7), in particular in areas characterized as sand/rubble (orange), colonized pavement south (green), rubble with colonized pavement (aqua), unconsolidated sediment (beige), and channel wall (brown). The rubble with colonized pavement area is within the Port Everglades injury area, and Gilliam and Walker (2008) estimated 7,698 scleractinian corals within this area (1.06 acres surveyed) with 1,094 corals larger than 10 cm diameter. The largest coral documented was 35 cm (*Solensatrea bournoni*). The colonized pavement south area (0.73 acres surveyed), which is also within this injury area, was estimated to have 3,597 scleractinian corals with 594 corals greater than 10 cm diameter. The largest documented coral was also 35 cm (*S. bournoni*).

In 2001, DCA collected video and field data from nearshore hardbottom habitats located near Port Everglades. DCA characterized the hardbottom areas as exposed rock with a fine covering of sand. The biological communities were characterized as dominated by algae and sponges with interspersed gorgonians and scleractinian corals. Photos depicted several species of corals located along this nearshore hardbotom, including *Acropora cervicornis* (Figure 6). Approximately 22.7 ac of nearshore hardbottom is located within the 150 m indirect impact area is 4.78 ac and the Submerged Breakwater habitat is 17.19 ac (Walker et al. 2008b) (Table 7).

Figure 7: Overlap of Gilliam and Walker (2008) study area, referred to as "B" with Port Expansion, referred to as "A"



6.3 Description of Cumulative Coral Age within the Expansion Area

In determining coral age, corals can first be grouped based on life history functions such as growth rate, reproduction (fecundity, mode of larval dispersal, recruitment success), morphology, the ability to develop coral reef framework, and other factors. For this estimate, scleractinian corals were grouped into one of three major categories including massive, brooders, and branching. This categorization does not work well for some corals, for example the cup coral (*Phyllangia americana*) which was observed in the project area (DCA 2006). However this other category of corals represent less than 0.1% of the total corals documented in the project area, and they can be assessed separately.

Most growth rates (linear extension) for *Montastraea*, *Porites*, and *Diploria* are less than 1 cm/yr (SAFMC 2009). Hubbard and Scaturo (1985) report average extension rates of 0.12 to 0.45 cm/yr for several species [documented in the Port Everglades Expansion area] including *Stephanocoenia intersepta*, *Agaricia agaricites*, *Diploria labyrinthiformis*, *Montastraea cavernosa*, *Porites astreoides*, and *Siderastrea siderea*. Consideration of how old the scleractinian corals are in the Port Everglades expansion area can provide context for describing the affected environment. Coral age within a project area by species and size class, in addition to several other factors, can be fed into a resource equivalency analysis (e.g., Habitat Equivalency Analysis or HEA) to scale a compensatory mitigation requirement. However, this approach does not consider the loss of coral reef framework (see habitat area estimates in

Table 7), which would also need to be a component of any effort to scale the compensatory mitigation requirement associated with Port Everglades expansion.

All coral species documented in DCA (2006) were assigned as branching, brooding, or massive. Quantitative data from DCA (2006) was only available for scleractinian corals from the Middle and Outer Reef areas and this evaluation is limited to these assessment areas. DCA (2006) groups corals into 4 size classes (Table 6). Since actual measured sizes of individual corals are not provided in the report, the mean coral size within each size class was used. For example for size class II, 7 cm is used as the mean coral size. For size class I, 2 cm is used as the mean, since the report states that organisms less than 1 cm were not identified (DCA 2006).

<u>Determining Coral Age by Coral Type and Size Class</u>
The sum of all corals within each size class for each group of coral was estimated by multiplying the percentage of each type of coral per size class by the total number of scleractinian corals within the project impact areas. Using coral colony density estimates provided in DCA (2006) (86,248 scleractinian within the project impact areas), which were derived from Table 6, the estimated colonies measuring 7 cm in diameter (size class II) are approximately 31,542 massive corals. Therefore, approximately 36.5% of the corals in the project impact area are massive corals that average 7 cm in diameter (size class II). Known growth rates from published literature for each category of coral (summarized in Tables 8 and 9) were then multiplied by the average size of each size class to obtain the average age of each coral in each size class. For massive corals, 0.560 cm/year is used. Therefore, a size class II massive coral is approximately 12.5 years old. Finally, this age was multiplied by the estimated number of colonies in the impact area to get the total lost age of corals in each size class. For example, for massive corals in size class II, this amounts to 394,275 years.

<u>Massive Corals</u>
The massive category includes (but is not limited to) the *Montastrea* complex, the *Diploria* spp., *Solenastrea bournoni,* and *Siderastrea siderea* (see Table 4). These corals are generally broadcast spawners and the main framework builders on Atlantic/Caribbean reefs. In southeast Florida, most species spawn over a few nights clustered around the full moon in later summer. Larval recruitment is rare (Kojis and Quinn 2001) and slow (Clark and Edwards 1999). In areas like southeast Florida with lower coral cover density, a dependency on synchrounous spawning may constitute a major life history bottleneck for broadcast spawners (SAFMC 2009). Approximately 72% of the corals documented in DCA (2006) are classified as massive corals. Based on the coral colony density estimates provided, 62,159 corals would be massive corals. Based on a review of the literature, the average growth rate for massive corals is estimated to be 5.60 mm/yr (Table 8). Therefore the cumulative age of massive corals in the Port Everglades expansion area is approximately 757,041 years (Table 10).

Table 8: Literature review of massive coral growth rates conducted by NOAA Restoration Center (Tom Moore and Sean Griffin, NOAA Restoration Center, personal communication, 2011).

Source	Reference	Range (mm/yr)		Average
Edmunds 2007	*Diploria* spp.	5.3	7	6.15
Vermeij 2006	*Diploria* spp.	6	6	6
Hubbard & Scaturo 1985	*D. labrynthiformis*	3.3	4.6	3.95
Highsmith et al. 1983	*M. annularis*	6.3	6.3	6.3
Hubbard & Scaturo 1985	*M. annularis*	2.9	10.2	6.55
Highsmith et. Al., 1983	*M. cavernosa*	4.3	4.3	4.3
Hubbard & Scaturo 1985	*M. cavernosa*	2.9	4.5	3.7
Hubbard & Scaturo 1985	*Siderastrea siderea*	1.5	3	2.25
Edmunds 2007	*S. siderea*	2.2	5.2	3.7
Bright et al. 1984	*M. annularis*	5	5	5
Carricart-Ganivet & Merino 2001	*M. annularis*	6.8	10.03	8.415
Carricart-Ganivet et al. 2000	*M. annularis*	6	10.54	8.27
Dodge 1981	*M. annularis*	7.9	10.5	9.2
Foster 1980	*M. annularis*	5.28	5.28	5.28
Guzman et al. 2001	*M. annularis*	6.3	10.2	8.25
Hudson 1981	*M. annularis*	5	11.3	8.15
Leder et al. 1991	*M. annularis*	5.3	5.3	5.3
Foster 1980	*S. siderea*	3.9	3.9	3.9
Guzman et al. 2001	*S. siderea*	3.8	5.7	4.75
Guzman et al. 1994	*S. siderea*	4.2	4.5	4.35
Ruesink 1997	*S. siderea*	5.5	5.5	5.5
Stern et al. 1977	*S. siderea*	4.1	5.4	4.75
Soong & Lang 1992	*S. siderea*	5	5	5
		4.729565	6.48913	5.609348

<u>Brooding Corals</u>

The brooder category includes (but is not limited to) the *Agaricia* complex, *Favia fragum*, *Porites astreoides*, and *Siderastrea radians* (Table 4). Recruitment, especially in injured areas, is generally dominated by the brooding species (Miller et al. 2009). Brooding species often release larvae on a lunar cycle over several months or year round (SAFMC 2009). Brooders tend to have a high reproductive output due to the ability to self-fertilize and settle shortly after release. Brooders do not generally attain large colony size and therefore have limited contribution to coral reef framework building (Smantz 1989). Brooders also have a high tolerance to transplantation stress (Gleason et al. 2001).

Approximately 26% of the corals documented in DCA (2006) are classified as brooders. Based on the coral colony density estimates provided in DCA (2006) (86,428 scleractinian corals on the Middle Reef and Outer Reefs within the direct project footprint), 22,340 corals would be brooders. Based on a review of the literature, the average growth rate for brooders is estimated to be 4.88 mm/yr (Table 9). Therefore the cumulative age of brooding corals in the Port Everglades expansion area is approximately 359,565 years (Table 10).

Table 9: Literature review of brooding coral growth rates conducted by NOAA Restoration Center (from Tom Moore and Sean Griffin, NOAA Restoration Center, personal communication, 2011)

Source	Reference	Range (mm/yr)		Average
Edmunds 2007	*Siderastrea radians*	1.7	4.2	2.95
Bastidas & Garcia 1999	*Porites asteroides*	2.1	3.5	2.8
Bak & Engel 1979	*Agaricia* spp.	8	8	8
Gladfelter et al. 1978	*P. astreoides*	3	3.5	3.25
Gleason et al. 2001	*P. astreoides*	2.6	3.5	3.05
Guzman et al. 2001	*P. astreoides*	3.9	6.2	5.05
Guzman et al. 1994	*P. astreoides*	4.3	4.6	4.45
Highsmith et al. 1983	*P. astreoides*	2.9	6.9	4.9
Huston 1985	*P. astreoides*	2.2	4.5	3.35
Rogers et al. 1984	*Agaricia* spp.	14.4	14.4	14.4
Hughes & Jackson 1985	*Agaricia* spp.	5.8	5.8	5.8
Vermeij 2006	*Agaricia* spp.	5	5	5
Vermeij 2006	*P. astreoides*	3	3	3
Carlon 2001	*Agaricia* spp.	5	5	5
Edmunds 2007	*P. astreoides*	3.7	6.1	4.9
Edmunds 2007	*Agaricia* spp.	2.2	5.2	3.7
Edmunds 2007	*Favia fragum*	2.1	4.7	3.4
		4.229412	5.535294	4.882353

Branching Corals

The branching category is limited to *Porites porites*, as other branching corals – e.g., *Acropora cervicornis* and *Dendrogyra cylindrus,* were not documented in the expansion area by DCA. Approximately 2% of the scleractinian corals documented in DCA (2006) are branching corals. Based on the coral colony density estimates provided, 1,928 corals in the Port Everglades expansion area would be branching corals. Based on a review of the literature, the average growth rate for *P. porites* is estimated to be 14.1 mm/yr (Hubbard and Scaturo 1985), however in the case that other branching corals are documented in the study area (e.g., *Acropora cervicornis*), an adjustment here would need to be made. Therefore the cumulative age of branching corals in the Port Everglades expansion area is approximately 9,603 years (Table 10).

Other Corals

The other coral category is a catchall for cup corals and other corals such as *Leptoseris cucullata*[2]. Not much is known about growth rates for these species, however these species represent less than 0.1% of the corals in the project area at the time of the DCA survey in 2006. Coral age estimates for this category would have to be determined separately.

Scleractinian Coral Age Estimates within the Expansion Area

Based on examination of coral age within the expansion area using data from DCA (2006) as a way to describe the affected environment, approximate cumulative age of corals in the expansion area is 1,126,209 years (Table 10).

[2] Also referred to as *Hellioseris cucullata*

Table 10: Summary of coral age estimates by coral type in the Pt Everglades expansion area

Type of coral	Avg growth rate	Estimated #	Coral Age
Massive	5.6 mm/yr	62,159	757,041
Brooding	4.9 mm/yr	22,340	359,565
Branching	14.1 mm/yr	1,928	9,603
Total			1,126,209

6.4 Scleractinian Impact Scaling Using Size/Species-Frequency Distribution Resource Equivalency Analysis within the Middle and Outer Reef

In light of their designation as EFH-HAPC's and Executive Order 13089, federal agencies apply greater scrutiny to projects affecting corals, coral reefs, and hardbottoms to ensure practicable measures to avoid and minimize adverse effects to these habitats are fully explored, and in the case that unavoidable impacts are planned, compensatory mitigation is based on the best available approaches and scientific information. There are several approaches which can be used to describe the affected environment and consider the total services that would be lost within the proposed Port Everglades expansion impact areas. One of NOAA's preferred approaches uses a Size/Species Frequency Distribution Resource Equivalency Analysis. As described in Viehman et al. (2009), this modified type of HEA, uses a resource-to-resource method that references the number organisms lost and the number gained through mitigation. In the coral reef environment this approach typically looks at the size-frequency distributions at the species or functional group level to reflect the life history strategies of different corals and allows representation of the (typically non-linear) relationship between services and colony size, thus providing insights into ecological function. Using this approach the metric for scaling becomes a coral colony year (CCY) – which is not equal to the coral age; rather CCY is a proxy for services provided and/or, in the case of any injury, lost during a one year period of time for a particular size and type of coral. While the initial CCY value is only directly comparable to others within the same size/species group equivalency, between sizes and groups can be gained by utilizing a combination of a linear size and service weighting. The key inputs into this analysis are the size/species distribution and the recovery time. The analysis also considers discounting and other important HEA inputs. Importantly, this analysis can help determine if the appropriate coral species and size classes are scalable with respect to the amount and type of compensatory mitigation that is planned.

7. Port Everglades Habitat Linkages

The Port Everglades area is similar to other areas at latitudes that support coral reefs, in that the natural seascape is vegetated primarily by seagrass beds and mangrove wetlands. Within this seascape, many exploited coral reef fishes occupy inshore regions as juveniles before migrating offshore to reproduce thereby undergoing an ontogenetic pattern of habitat utilization. In tropical ecosystems of the Atlantic/Caribbean, coral reefs, mangroves, unvegetated bottom, and seagrass are all physically, chemically and biologically connected. For example, coral reefs dissipate wave energy and promote physical conditions promoting growth of the seagrass and mangroves, both of which filter sediments and protect reefs. As described in the section above, coastal inlets are migratory corridors for fishery resources that utilize oceanic and estuarine habitats. Although not well studied, the biogeography of the Port Everglades area provides for a unique landscape and ecological linkages between coral reef, mangrove, and seagrass habitats in terms of flux of energy and physical occupation of habitats.

Mangrove and seagrass beds are essential habitats for fishes, including species commonly found on reefs. Life history stages that utilize these habitats include the critical early stages (egg, larval, settling, postlarvae, and developing juveniles). Mangrove and seagrass habitats intercept large numbers of larvae and provide abundant food resources and protection from predators (Parrish 1989). These biotopes are also located such a distance from offshore that they are less frequented by predators (Parrish 1989). Furthermore, the turbid waters in these areas may decrease the foraging efficiency of predators (Blaber and Blaber 1980)

Coral reef fishes often use shallower habitats as juveniles (Lindeman et al 2000) and various combinations of these habitats may be used during adult diurnal feeding migrations or seasonal shifts in cross-shelf distributions (SAFMC 2009). Nagelkerken et al. (2000) document that Lutjanidae and Haemulidae settle in seagrass beds rather than on reefs. Other species represented in seagrass beds and mangrove estuaries include juvenile mutton, gray, dog, lane (*Lutjanus synagris*), and yellowtail snappers; and goliath, red, and gag groupers; and hogfish (SAFMC 2009). In addition, early juvenile Nassau grouper (*Epinephelus striatus*) have also been found to use macroalgal habitats along mangrove-lined channels (Eggleston 1995). Habitats within Port Everglades may provide EFH for newly settled stages of mutton snapper, which are known to occur in seagrass habitats (Gilmore, unpubl. data) and generally use mangrove prop roots or adjacent shallow rock and coral reef formations as larger juveniles (Gilmore, unpubl. data). Similarly, Mumby et al. (2004) found that the community structure of coral reefs was influenced by the presence of mangroves in the vicinity, and the total adult biomass of several species was higher.

In addition to occupying habitats, the habitat mosaic in the Port Everglades area also provides important energy exchange. For example, white grunts (*Haemulon plumier*), which are fished commercially and recreationally throughout their range (Potts and Manooch 2001), are important in energy exchange between reef and seagrass communities (Darcy 1983). As mentioned in the soft bottom habitats section, adult white grunts are generalized carnivores which feed mainly on benthic invertebrates (Potts and Manooch 2001). These include echinoderms, polychaetes, majid crabs, alpheid shrimp, isopods, other shrimp, crabs, and small fish (Randall 1967; De Silva and Murphy 2001; Darcy 1983). Because of their abundance, they are probably important prey for many larger species of groupers and snappers (Darcy 1983).

Collections in both seagrass beds and mangroves suggest that there is an integral link between these habitats with tripletail, snook, gray snapper, red drum, and goliath grouper, for example, occurring over seagrass beds or other adjacent bottoms as adults or large juveniles, but using the mangrove prop-roots as habitat during juvenile stages. Spotted seatrout, striped and white mullets (*M. curema*) and great barracuda (*Sphyraena barracuda*) juveniles are also common inhabitants (SAFMC 2009). There are also recognizable and predictable interactions where different life stages of fish move between reefs and seagrass beds on a diurnal basis. The best known examples in Florida are species of grunts which utilize reefs by day and seagrass beds by night.

Two species known to be present within coral reef habitats within the Port Everglades expansion area, gray snapper and bluestriped grunt, use vegetated habitats during their ontogeny (Faunce and Serafy 2007). In this study, both species exhibited a three-stage ontogenetic strategy, including settlement and grow-out within seagrass beds, expansion to mangrove habitats, and increasing utilization of inland mangroves during the dry season and with increasing body size. They also observed that for fishes inhabiting mangroves, the distance from an oceanic inlet and water depth were stronger predictors of reef fish utilization than factors like latitude, temperature, or habitat width. These findings highlight that the nursery function of mangrove shorelines is likely limited to the area of immediately accessible habitat, and that more expansive mangrove wetlands may contain a substantial number of larger adult individuals. It has also been suggested that the presence of mangroves and seagrass beds serve as extra “waiting room” habitats for juvenile coral reef fishes, and that adopting such a life-history strategy may buffer against poor recruitment years (Parrish 1989).

The Port Everglades expansion area landscape provides for an important and complex set of ecological linkages between coral reef, mangrove, seagrass, soft bottom, and coastal inlet habitats in terms of flux of energy and physical occupation of habitats. Complex modeling studies would be needed to examine how fish would respond to the synergistic effects of the losses of multiple habitat types that support various life stages of fishery resources within the Port Everglades expansion area.

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